Malaria Control in Turkey

By FREDERICK W. KRATZ, M.D., and
C. BRADLEY BRIDGES, M.P.H.

TURKEY—astride the strategic Bosporus and Dardanelles—has long been a land of mystery and enchantment to the average American. Its civilization is what one would expect of a country which lies partly in Europe and partly in Asia. Though turned toward the West in thought and ideas, it is a nation blending the customs of Eastern and Western cultures in spite of the prediction that "ne'er the twain shall meet."

Asia Minor, or Asiatic Turkey, is about 97 percent of the total land area of the country (287,246 square miles). Thrace, the extension of the European Balkan Peninsula, occupies only about 3 percent. Both portions of the once great Ottoman Empire are historically malarious. The Sultan's soldiers, returning from World War I to rally around Kemal Ataturk, not only maintained malaria in epidemic proportions but brought with them strains of new plasmodia, which swept through the homeland with renewed energy (*1*, *2*).

In the years since the founding of the Republic of Turkey, in 1923, great emphasis has been given to improvement of the general health. Malaria incidence has been in general decline since 1946 as a result of the persistent control operations under the Directorate of Malaria Control (*3*). These efforts had long been hampered by general shortages of funds, equipment, and insecticides.

In May 1950 the United States Economic Cooperation Administration Health Mission to Greece sent representatives to Turkey in order to establish the basic agreements which led eventually to a program of material and technical assistance in malaria control.

In November of the same year a working agreement was set up between the Economic Cooperation Administration and the Turkish Ministry of Health and Social Assistance. The ECA public health group, composed of a physician, sanitary engineer, and malariologist, arrived in Ankara in March 1951 to work as consultants in the malaria control operations of the Turkish Ministry of Health until the close of the assistance program, June 30, 1953.

Material assistance furnished under these agreements included principally insecticides, sprayers, and automotive equipment.

Progress in International Cooperation

Turkey has four separate topographical regions whose climates are completely different. Each region presents its problems in the control of malaria.

Asiatic Turkey is almost completely ringed with mountains which fall away rapidly toward

Dr. Kratz and Mr. Bridges went to Turkey in 1951 as public health consultants. Dr. Kratz, who is medical officer in charge, Pacific Northwest Foreign Quarantine District, Public Health Service, Seattle, was chief of the public health group during the malaria control program. Mr. Bridges was the malariologist with the group and is now training officer at the Communicable Disease Center, Public Health Service, Atlanta. The third member of the group was George W. Hintgen, malaria control engineer.

the sea, forming a strip of flat coastal plain of varying width. This plain is adjacent to the Black, Marmara, Aegean, and Mediterranean Seas. European Turkey is also a coastal plain since it is the corresponding area between the Balkans and the Black, Marmara, and Aegean shores.

Malaria has been firmly entrenched in the coastal plain for centuries. This is particularly true of the Aegean and Mediterranean areas where Greek and Roman cities suffered the ravages of the disease. Its ample rainfall and mild-to-tropical climate make it still the area requiring most attention.

The watershed from the coastal side of the mountains, the flood plains of great rivers entering the sea, and the outcropping of the water table furnish ample mosquito-breeding habitats in the form of pools, marshes, and seepage areas. In the south the mosquito-breeding season is continuous, with only minor recessions in winter. Progressing northward, more definite seasonal lines may be drawn.

More than half the land area of Turkey is in Anatolia, a high, saucer-shaped plateau, much like the arid plateaus just east of the Rocky Mountains in the United States. Anatolia, the Turkish homeland, may be called the heart as well as the breadbasket of the country.

The winters are cold and the summers are hot with cool, breezy nights. Continuous warm weather does not begin until very late spring, confining mosquito breeding generally to the months from June to October. Dry summers limit malaria transmission to areas adjacent to water courses or to the numerous brackish marshes and lakes. Villages are, of necessity, located near water sources, thereby making malaria control services obligatory in most areas of Anatolia. The necessity of irrigation is general. However, the annual grain crop is largely dependent on the heavy snow and rain of winter.

Since large parts of Anatolia are not drained by the big river systems, runoff water often accumulates in large marshes and lakes. This makes wasteland of vast areas. Spring floods expand their size enormously, and summer drought greatly reduces them, leaving crusty layers of mineral salts after the water evaporates.

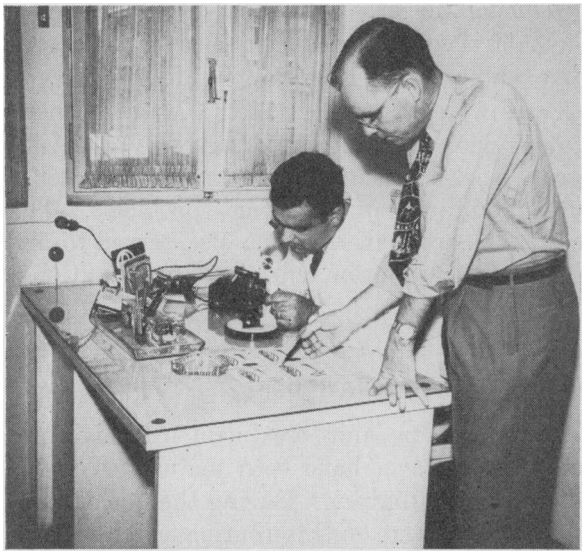
The rugged mountain country of eastern Anatolia has narrow, fertile valleys where good crops of grain and fruit are grown. The severe winters, short summers, and restricted breeding areas place natural limitations on malaria. Southeast Anatolia is a foothill region where the mountains decline to the rolling hills of Syria, Iraq, and Iran. Primitive living conditions plus long, hot, dry summers, which are relieved by heavy autumn, winter, and spring rains, make malaria control measures necessary. Some of the highest spleen rates are reported from southeast Anatolia.

Prior to the arrival of Osmanli, or Ottoman Turks, in the 11th century A. D., the residual population of Asia Minor was subjected to the sweeping tides of conquests from both the East and the West. Almost any racial characteristic can be found from the Mongoloid to the Nordic, but the people are predominantly of the Mediterranean type. The highest population densities are found in the approaches to Europe, that is, the Marmara and Black Sea coastal plains. Not only are many of the larger cities located there, but the towns and villages are larger and more numerous.

Turkey is predominantly a rural nation. Only 7 percent of its population lives in the urban centers above 50,000 in population. The term "rural" as applicable to the United States cannot be used here. Isolated homesteads are nonexistent. The entire population lives in communal groups from small villages to larger towns and cities. In the United States we speak of malaria as being a rural problem, but in Turkey it is a village problem.

Malaria has no doubt played a leading role in shifting greater densities to the Marmara and Black Sea coasts. Along the Aegean there have been Roman and Greek cities of fabulous size and grandeur—Troy, Ephesus, Perga, Aspendus, Soli, and Korykos. They are ruins today, mute evidence of the combined influence of malaria, decadence, and earthquakes. Even in recent years, Antalya, the modern counterpart of Perga, has reported malaria rates as high as 85 percent (*1*).

A large majority of the people are engaged in various agricultural pursuits, which include herding livestock as well as intensive cultivation of small vegetable farms. Through the



Studying the biology of vectors.

years activity patterns have evolved which substantially increase the opportunity of malaria transmission in the presence of capable vectors.

The sparse summer rainfall in most of Turkey necessitates the extensive use of irrigation during the growing season. The improper management of irrigation water in rice culture and in other crops leads to a malaria problem here as well as elsewhere in the world.

The danger from rice irrigation is somewhat reduced by a law which requires that all rice fields less than 3 kilometers from a village be dried 48 hours every 10 days, but there is no such control on water used in irrigation of other crops to lessen mosquito breeding (*4*).

The lack of fences in Turkey has led to the custom of crop watching. During fruiting time a watch is maintained from an elevated platform day and night against marauding men and livestock. The guard is often joined by his entire family. With a most convenient blood meal near at hand, the vectors need not travel to the villages or herds to fill their needs. A similar blood-feeding situation results when the people sleep on rooftops to escape the inside heat on hot summer nights.

As in the United States, laborers migrate from one area to another during the harvest season. They live in tents or other temporary dwellings impossible to cover in a control program, then return when the harvest season is over to their Anatolian homes, carrying infections with them. Migrations of a lesser magnitude are those of a few nomadic tribes who follow grazing as the seasons open or close.

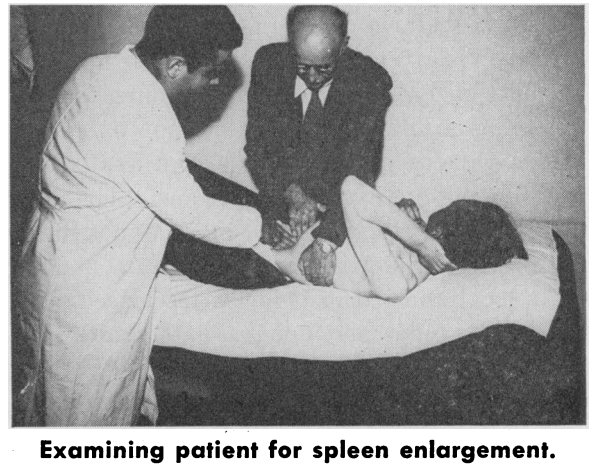
The Malaria Control Organization

Owing to the prevalence of malaria in Turkey in the period following World War I and the early days of the Republic (*5*), malaria control activities were begun on a national level by the Ministry of Health and Social Assistance in 1925.

Studies of the mosquito fauna in those years established the presence of such formidable vectors as *Anopheles superpictus* as well as *Anopheles sacharovi*. Although the existence of three subspecies of *Anopheles maculipennis* was also established, these subspecies (*typicus*, *messeae*, and *melanoon*) were fortunately not the efficient vectors of southern Europe (*6*). Seven other *Anopheles* were established, namely, *algeriensis*, *claviger*, *marteri*, *multicolor*, *plumbeus*, *sergentii*, and *hyrcanus* (*7*).

The malaria workers of the Directorate of Hygiene enjoyed reasonable progress until the World War II period. Economic crises and shortages brought widespread epidemics to the Mediterranean and Aegean areas. In 1946 malaria control was set up as a separate division for the administration of the program. The National Assembly gave legal authority to the new agency to control malaria by almost any effective means (*4*).

Operating at a high federal level, the directorate, under the Ministry of Health and Social Assistance, carried out its program through



Examining patient for spleen enlargement.

provincial and district medical directors at the local area. This same type of organization is still in existence. With the advent of United States cooperation, new areas were included in the control program.

The sanitarian is the key man at the local level. Though subprofessional by training and experience, he is responsible for substandard diagnostic screening of malaria cases, the dispensing of antimalarial drugs, entomologic inspections, the supervision of residual spraying and larviciding, and the gathering of statistical data. He is directly responsible to a medical officer, who either substantiates or disproves the diagnoses made by the sanitarian. A sanitarian is assigned to 10 to 15 villages and is required to visit each village twice a month on schedule.

The Directorate of Malaria Control is administratively in control of the Malaria Institute in Adana, which is its training arm. Inservice training is generally given at three different levels.

1. Physicians are given a 6 weeks' course in all phases of malaria work from diagnosis to insecticide dispersal. On returning home, they give similar courses for their associates in the district and throughout the province.

2. Laboratory technicians are given training for a similar period in the preparation and identification of blood parasites as well as taxonomy of mosquitoes and other insects.

3. Sanitarians' inservice refresher courses usually are of 4 weeks' duration. Designed to meet the needs of sanitarians in the field, the subjects are approached from a practical point of view. Although coverage is given to all phases of malaria control activities, particular emphasis is given to insecticides, their use, and application. A formal 3-year course in all phases of sanitation activities prior to service in the various directorates is continually improving the quality of sanitarians. The supply of these graduate sanitarians does not fulfill the needs of the Ministry of Health.

At local and national levels inservice training of the older and nongraduate sanitarians is a major endeavor aimed at raising their efficiency in the broad field they cover in addition to the malaria control program.

During the period of United States assistance in malaria control, these courses were a cooperative enterprise. The Public Health Service officers were instructors at the Malaria Institute. Such joint undertakings served to improve working relations and to promote a deeper understanding of existing problems. The courses, more than anything else, served to disseminate information quickly to the operational level.

Malaria Control Operations

Examination and treatment of suspected cases of malaria have been mainstays of the operational program. During the normal season, a sanitarian on his routine visits to each village makes the diagnoses and issues antimalarials, usually atabrine. Guided by an operational manual, he maintains records dealing with every occupant of each house in the village. Such pertinent data as splenic enlargement, results of blood examinations, and age and sex of the occupants are recorded. The examinations of blood for malaria parasites are made by the local physicians and technicians assigned to the malaria control program.

Since 1946, a malaria survey has been made each fall by the district medical director in each village of the 34 control areas. Great emphasis has been placed on enlarged spleens as an index to the prevalence of malaria. Since 1951, more emphasis has been placed on blood examinations. Before this period, blood examinations

Table 1. Data on Turkish spleen examinations, 1946–54

Year	Population in control areas	Percent examined	Percent with positive spleens
1946	6, 032, 573	78. 1	25. 9
1947	6, 036, 073	73. 9	19. 8
1948	6, 403, 475	70. 3	14. 7
1949	5, 398, 767	80. 1	10. 5
1950	5, 307, 420	85. 6	7. 1
1951	5, 717, 394	90. 9	4. 3
1952	5, 983, 502	75. 5	2. 1
1953	[1]	[1]	[2] 1. 4
1954	[1]	[1]	[2] 1. 1

[1] Figures not available. [2] Percentages of positive spleens taken from reference 8.

Table 2. Percent of total hospital admissions and deaths among malaria admissions, 1946–51

Year	Percent of admissions	Percent of deaths
1946	5. 0	2. 6
1947	3. 6	2. 4
1948	3. 2	2. 0
1949	2. 7	1. 6
1950	1. 6	1. 4
1951	1. 4	1. 1

Table 3. Progress in reduction of malaria incidence, 1946–52

Year	Spleen index	Percent reduction
1946	25. 9	
1947	19. 8	24
1948	14. 7	26
1949	10. 5	28
1950	7. 1	30
1951	4. 3	54
1952	2. 1	40

were confined to persons having highly indicative clinical symptoms. Presently these surveys cover:

Spleen examinations for all inhabitants of village included under malaria control.

Blood smears on all children up to 10 years of age.

Blood smears on all persons having positive spleens.

Owing to the fact that the results of blood and spleen surveys through the years cannot be correlated, only the results of the spleen examinations have been tabulated. Blood examinations were done for the past 5 years, and spleen surveys were carried on for 27 years. Tables 1–3 cover only the results of village or rural examinations. There are clinics in the cities and large towns where people seeking medical treatment are examined. Should these reports be included, the population protected would be more than 9 million, or nearly half the total population.

Since some 80 percent of the malaria reported in Turkey is caused by *Plasmodium vivax* (*1*), Turkish physicians are accustomed to have between 20 percent and 30 percent of their treated patients relapse under the present system of therapy. Any new drug on the market that can reduce this relapse rate is looked upon with great anticipation. The efficacy of primaquin with chloroquin has been covered in numerous training courses and conferences. The adoption of the use of more effective antimalarials is further hindered by the fact that a large stock of atabrine was brought from Egypt in 1951.

Vector Control

The success of any control measure in Turkey is dependent on how well the measure ties in with the habits of *A. sacharovi* and *A. superpictus*. Although there are anopheline vectors (*A. claviger*, *A. bifurcatus*, and *A. sergentii*) present which are of importance in other areas, in Turkey they are of secondary importance. Village houses are used to shelter animals as well as humans. Readily available animals for blood meals doubtless form protective barriers around man which are penetrated mainly by those primary vectors (*A. sacharovi* and *A. superpictus*) which show a definite preference for human blood.

Several of these anophelines have characteristics so similar that the species are separated only with difficulty. Identification involved time and equipment out of proportion to our systems. A primary accomplishment of the period of United States cooperation was the development of a simple pictorial key by which species could be separated in the field with a hand lens.

A program of routinely collecting larvae and adult mosquitoes was introduced also. Morbidity records have existed for some time. By correlating records of morbidity and vector indexes, justification for control operations can be established.

Since limited amounts of DDT were available for malaria control in the past, considerable emphasis was placed on oil larviciding of breeding areas. DDT first became available to Turkey in 1946, beginning with 2 tons, and gradually increasing to almost 100 tons in 1949. As more DDT became available from United States aid (750 tons a year for the next 3 years), larvicides were deemphasized, and DDT residual spraying assumed a more important role.

Mixing spray materials.

Where larviciding is indicated, it is accomplished with the use of a DDT solution made with fuel oil to which a spreading agent was added. Applications approximating 1 gallon an acre (0.1 pound DDT) in a fine mist spray are the rule.

Heavier residual larvicidal applications with DDT emulsions (3 pounds an acre) are used in selected locations on isolated ponds. Since many of these ponds dry up in midsummer, a single application will suffice for the season. These applications result in a considerable saving in the cost per acre-week over the older oil-larviciding methods.

Major drainage works are the responsibility of the Turkish Ministry of Public Works. Since the ministries coordinate their drainage projects through this agency, drainage on a large scale for malaria control alone does not occur. It is usually tied in with such projects as land reclamation, but still the benefits extend to malaria control.

Malaria control workers are trained in the fundamentals of drainage which they apply on a local level in small hand drainage projects. The effectiveness of residual spraying in controlling malaria has largely reduced drainage operations to the maintenance of existing ditches and small channels.

DDT Residual Spraying

Malaria in Turkey can be controlled by directing control activities only at the mosquitoes which play a role in the actual transmission of the disease. This principle of control by "species sanitation" requires a deeper understanding of the life history and habits of the vectors so that an attack can be made at a vulnerable point. The purpose of DDT spraying in homes is to control the vectors at the point where blood meals are taken from man, and where the accompanying transfer of parasites takes place, that is, in homes where humans are attacked during sleeping hours or other periods of inactivity.

The most important vectors in Turkey enter barns and houses in search of victims from which a blood meal may be taken. Sometime during this sojourn the anopheline will seek a quiet dark place in which to rest. This rest may come after its flight from the breeding area or after it has heavily gorged on the victim's blood. If DDT residues have been applied to every likely resting place, the infected mosquitoes are killed, breaking the chain of transmission.

DDT spraying on this basis has given protection to more than 9 million people each year since American aid was instituted in 1951. This assistance greatly increased the amounts of DDT available for more extensive coverage and made possible the inclusion of more villages in the operational area. Lack of adequate quantities of DDT previously limited spraying to selective spot applications within houses and also limited the number of houses to be sprayed in the selected villages. For the first time skilled DDT spraying became available for every house in each village.

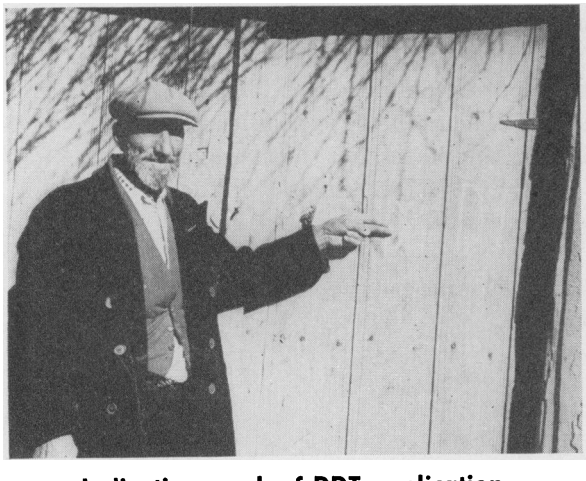
An efficient spraying of all buildings at a dosage of 2 grams a square meter (214 milligrams a square foot) in each village in malaria control areas is being achieved. These buildings normally include stables, dwellings, mosques, shops, and village halls. The single

annual application is performed during a 6-week period in the spring. However, in the more tropical regions where there is no marked break in the mosquito-breeding season, two or more additional applications are required.

For the most part, the buildings in rural Turkey are constructed of mud and similar materials. More than 80 percent of the buildings have these porous and absorptive surfaces for which emulsions and solutions of DDT are not suited. Therefore, water-wettable suspensions of DDT have replaced these other formulations. Solutions and emulsions are used for spraying less absorptive surfaces for areas where the white residue of water-wettable DDT would be objectionable. The flat fan spray nozzles with delivery rates of 0.2 and 0.4 gallon a minute are standard equipment in all spray operations. The stainless steel tip nozzle, which is designed for delivery at 0.4 gallon a minute, has given better service with DDT suspensions than the brass tip nozzle because erosion does not enlarge the aperture so quickly.

DDT has been used in limited amounts since 1946 with no reported ill effects to humans since adequate precautions have been taken to protect food, utensils, and sprayer operators. In some provinces in 1952, DDT was believed to have contributed to a high mortality in silkworms. Silkworm culture is carried on inside homes, and spraying in the homes leads to obvious difficulties. Special instructions excluding the homes from spraying operations have thus far prevented a recurrence of damage claims.

General insect control to a high degree has been achieved during the past three seasons with chemicals. The spray program has been popular, more often for comfort and convenience than for malaria control. People outside the 12,600 villeges under control have attempted various means to have their villages included in the program.



Indicating mark of DDT application.

Water-wettable DDT is mixed for spraying in a Kurd village in eastern Turkey. Note goatskin water bags.

In Turkey, as in all other parts of the world, houseflies have developed some tolerance to DDT. Though many claims of resistance can be attributed to localized operational inadequacies, the main fault lies in the fact that housefly control is unobtainable after a few years of DDT spraying and related chemicals, when such measures are not part of an integrated sanitation program which includes proper disposal of garbage and human wastes.

The reports of resistance in *A. sacharovi* from Greece caused some concern, but where efficient spray operations prevailed there were no credible parallels observed in Turkey. Most cases investigated revealed that DDT residues had been masked by smoke, greases, and the like, or that hard-to-reach surfaces had not been sprayed.

The existence of true resistance or modified behavior patterns due to irritant repellancy of DDT (*9*) was not established by biological tests during the period of American aid in malaria control.

Malaria in Turkey has been reduced to a fraction of its former incidence. As in many parts of the world, the extensive and intelligent

use of DDT in a residual spray operation has greatly accelerated the rate of decline.

The reduction in transmission has been impressive, but still there is danger of localized sporadic outbreaks so long as chronic carriers and capable vectors remain. The malaria control organization offers a nearly perfect setup for a rigid surveillance program in the years to come. Village visitations continue, with greater emphasis given to case finding. More effective treatment is in progress under a more rigid medical direction. With some villages becoming free of malaria, additional emphasis can be given to those which still have reported cases of the disease.

The conversion of the existing organization to one of general public health services is a logical sequence as malaria decreases in importance. The trend from specialized to general public health services is in the formative stage, with sanitarians gradually broadening their activities. Thus, the Turks, with characteristic energy and persistence, have all but conquered a disease which plagued their land long before their ancestors captured it.

REFERENCES

(*1*) Suyev, M.: Sitma savasi chalismari. Albumu husnutabiat. (Investigation of fever in the Savas area. *In* The album of health.) Istanbul, Turksozu Matbaasi, 1953.

(*2*) Okan, S.: Turkiyede sitma savasi. (Fever in the Savas area in Turkey.) Bulletin No. 143 [in English and Turkish], Ministry of Health and Social Assistance of Turkey. Ankara, The Ministry, 1949.

(*3*) Control of malaria. *In* Foreign letters: Turkey. J. A. M. A. 142: 920–921, Mar. 25, 1950.

(*4*) Ustendag, E. H.: The works of the Ministry of Health and Social Assistance (Turkey) for twenty-five years. Bulletin [in Turkish]. Ankara, The Ministry, 1952.

(*5*) Turkish Ministry of Health and Social Assistance: Annual reports of the Directorate of Malaria Control, 1946–53. Ankara, The Ministry, 1954.

(*6*) Noyan, A.: Die geographische Verteilung der Malaria in der Turkei. Ztschr. f. Tropenmed. u. Parasitol. 2: 338–350, January 1951.

(*7*) Pek, R. A.: Sitma (fever). Adana, Turksozu Matbaasi, 1945, 68 pp.

(*8*) Fifth International Congress on Tropical Medicine and Malaria. *In* Foreign letters: Turkey. J. A. M. A. 154: 80, Jan. 2, 1954.

(*9*) Hess, A. D.: The significance of insecticide resistance in vector control programs. Am. J. Trop. Med. & Hyg. 1: 371–388, May 1952.

Mental Defectives and Epileptics in Public Institutions

There were more than twice as many first admissions as discharges from public institutions for the mentally defective in 1954, according to the National Institute of Mental Health, Public Health Service.

New cases numbered 12,485 or 8 per 100,000 population, while 5,815 patients were discharged and 1,026 readmitted. The average daily patient load for mental defectives and epileptics combined was 138,595, with 109,931 classed as mental defectives. The range of expenditures for patient care varied considerably among the States, but the average cost per patient-year was $1,039. Of the 157,770 patients on the institution books at the end of the year, 139,977 were listed as in residence.

The item on page 162 of the February 1956 issue incorrectly applied the figures above to public mental hospitals.