Survey of Animal Ringworm in the United States

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RINGWORM in animals appears to be sufficiently common in the United States to present a potential public health problem. In August 1953 a study was initiated to determine which fungi were the common causes of ringworm in animals, to obtain data concerning the epizootiology of ringworm, and to determine the role of animals in the spread of infection to man. The plan and the objectives of the study have already been described (*1*), and reviews of the literature on animal ringworm have been published recently (*2*, *3*). This paper summarizes the data accumulated during the 2-year period August 1953 through August 1955.

Veterinarians in 32 States assisted in the study, collecting specimens of hair from domestic, captive, and wild animals. In most of the wild animals, skin lesions were not present.

In the laboratory, all hairs were checked with a Wood's lamp for fluorescence, and, using 10 percent potassium hydroxide, a direct microscopic examination for fungus elements was made. Following this preliminary examination, the hairs were cultured on cycloheximide medium (*4*) and held at 25° C. for a minimum of 1 month before being discarded as negative.

Specimens of hair from 1,073 domestic animals were cultured. Dermatophytes were isolated from 277, or 26 percent. A summary of these results is presented in table 1. In addition, hair specimens from 1,465 wild and captive animals were cultured, and dermatophytes were isolated from 243, or 17 percent (table 2). Thus, a total of 2,538 specimens of animal hair were cultured and dermatophytes were isolated from 520, or 20 percent. Figure 1 shows the distribution of the study animals and the number positive for ringworm.

Five different pathogenic organisms were identified among the animal isolates. These included *Microsporum canis* from cats, dogs, monkeys, and a chinchilla; *Microsporum gypseum* from dogs, mice, and rats; *Trichophyton mentagrophytes* from dogs, chinchillas, guinea pigs, a kangaroo, mice, rats, and an opossum; *Trichophyton equinum* from horses; and *Trichophyton verrucosum* from cattle and a burro. In addition, a variety of *M. gypseum* which was designated *M. gypseum* (red variety) was isolated from rats and mice. Dr. L. Ajello, of the Communicable Disease Center's Mycology Unit, describes this variety as a new species. A similar organism has been isolated from soil obtained from Idaho and Washington by Cooke (*5*), from Michigan by Ajello, and from Georgia by Menges (*6*).

Lesions were found in 408 of the 520 animals with ringworm. Scaling, circular lesions with alopecia were most common. The most common locations of the lesions were the head, the neck, and the leg.

The animal hairs were examined by culture, by direct microscopic examination, and by Wood's lamp for fluorescence. Of 290 cases which were positive by culture, only 117 (40 percent) were positive by direct microscopic

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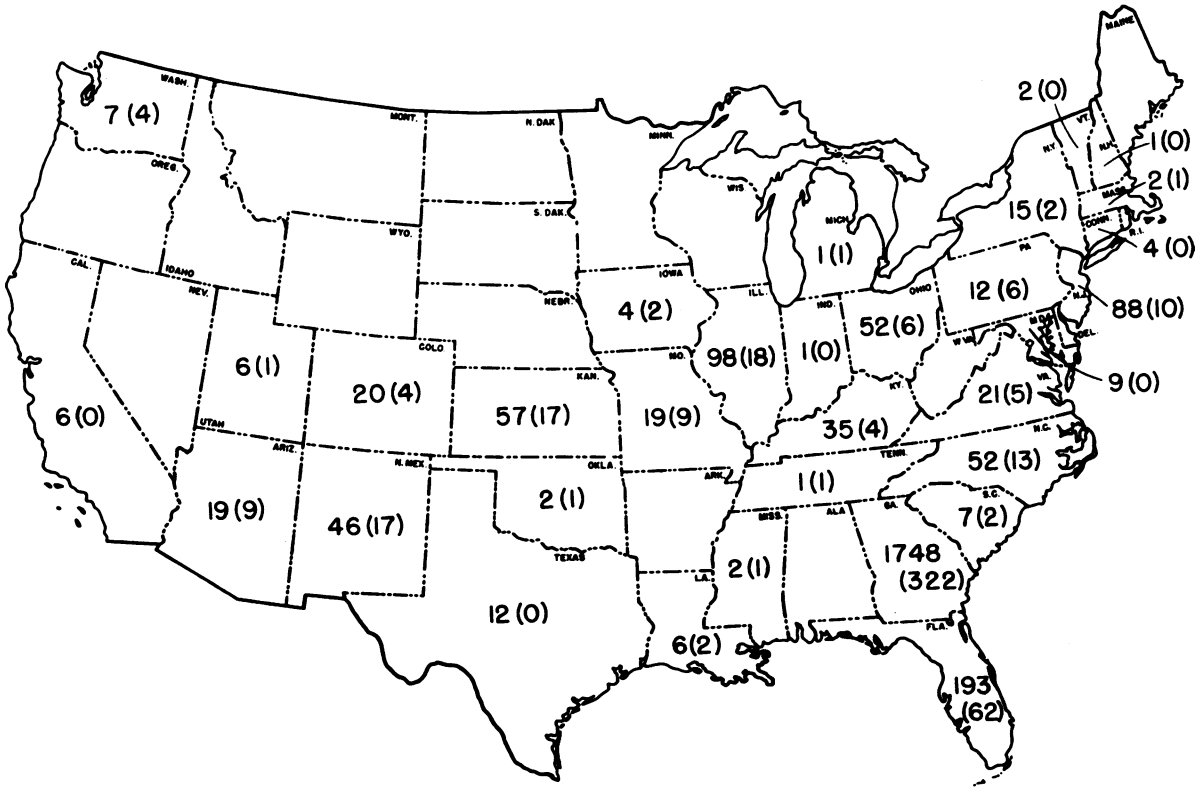
Table 1. Cultural results with domestic animal specimens

Animal and organism isolated	Specimens cultured					
	Total			No lesions		
	Number cultured	Positive		Number cultured	Positive	
		Number	Percent		Number	Percent
Cat (*Microsporum canis*)	281	125	45	92	23	25
Cattle (*Trichophyton verrucosum*)	105	21	20	61	0	0
Chicken [1]	2			2	0	0
Dog	641	127	19. 8	193	1	. 5
Microsporum canis	(641)	77	12	1	1	100
Microsporum gypseum	(641)	46	7. 2			
Trichophyton mentagrophytes	(641)	4	. 6			
Horse (*Trichophyton equinum*)	29	3	10	11	0	0
Burro (*Trichophyton verrucosum*)	1	1	100			
Mule [1]	2	0	0	2	0	0
Sheep [1]	1	0	0			
Goat [1]	1	0	0			
Swine [1]	10	0	0	8	0	0
Total	1, 073	277	26	369	24	7

[1] No isolations.

Figure 1. Distribution of ringworm cases in animals in 32 States participating in survey, August 1953 to September 1955.



NOTE: Figures indicate number of animals cultured; figures in parentheses, number of positive cultures.

examination and 46 (16 percent) by Wood's lamp. These results emphasize the value of cultures in diagnosing ringworm infections since *Trichophyton*-infected hairs usually do not fluoresce and infected hairs may be overlooked in direct examination.

Human Contacts

An attempt was made to gather evidence of the development of skin lesions in human beings in homes where infected animals were kept. A history of such lesions was found in 59, or 31 percent, of 192 families in homes in which 252 infected dogs and cats were kept. Presumptive ringworm was found in 14 of 120 (12 percent) of the families associated with canine cases and in 45 of 72 (63 percent) of the families associated with feline cases. This information was obtained from the owners of infected animals by the veterinarians who attended the animals and by followup studies.

Thirty-four human outbreaks were thought to be caused by infected cats and only 12 out-

Table 2. Results of culturing specimens of hair from wild and captive animals

Animal and organism isolated	Specimens cultured					
	Total			No lesions		
	Number cultured	Positive		Number cultured	Positive	
		Number	Percent		Number	Percent
Bat [1]	1	0	0	1		
Bird [2]	3	0	0	2		
Bobcat [1]	2	0	0	2		
Cheetah [1]	1	0	0			
Cat [1]	4	0	0	4		
Chinchilla	40	7	17. 5	21	0	0
Microsporum canis	(40)	1	2. 5	0		
Trichophyton mentagrophytes	(40)	6	15. 0	0		
Fox [1]	7	0	0	7		
Gerbil [1]	26	0	0	26		
Guanaco [1]	1	0	0	1		
Guinea pig (*T. mentagrophytes*)	200	141	71. 0			
Hamster [1]	1	0	0			
Jerboa [1]	16	0	0	16	0	0
Kangaroo (*T. mentagrophytes*)	1	1	100. 0			
Meriones [1]	12	0	0	8	0	0
Mice [3]	546	53	9. 7	545	53	9. 7
Microsporum gypseum	(546)	2	. 4	(545)	2	. 4
Microsporum gypseum (red variety)	(546)	36	6. 5	(545)	36	6. 5
Trichophyton mentagrophytes	(546)	15	2. 8	(545)	15	2. 8
Mink [1]	1	0	0			
Monkey (*M. canis*)	8	6	75. 0	2	0	0
Opossum (*T. mentagrophytes*)	59	1	2. 0	59	1	2
Rabbit [1]	11	0	0	7	0	0
Raccoon [1]	42	0	0	42	0	0
Rat [4]	471	34	7. 2	455	34	7. 4
Microsporum gypseum	(471)	2	. 4	(455)	2	. 4
Microsporum gypseum (red variety)	(471)	11	2. 3	(455)	11	2. 4
Trichophyton mentagrophytes	(471)	21	4. 5	(455)	21	4. 6
Skunk [1]	2	0	0	2	0	0
Squirrel [1]	8	0	0	8	0	0
Woodchuck [1]	2	0	0	2	0	0
Total	1, 465	243	17. 0	1, 210	88	7. 2

[1] No isolations.

[2] Canary, western evening grosbeak (*Hesperiphona vespertina*), warbler (unknown species).

[3] *Mus musculus, Peromyscus gossypinus, Peromyscus nuttalli, Pitymys pinetorum, Peromyscus polionotus, Rheithrodontomys humulis.*

[4] *Sigmodon hispidus, Rattus rattus, Rattus norvegicus, Neotoma floridans.*

breaks, by infected dogs. The number of individuals involved in any one outbreak varied from 1 to 16; the total number of suspected cases was 107. The outbreaks occurred in 16 States (fig. 2).

Infections in Dogs

Specimens of hair from 641 dogs were cultured; 127 dogs (19.8 percent) had ringworm. *M. canis* was isolated from 77 (12 percent), *M. gypseum* from 46 (7.2 percent) and *T. mentagrophytes* from 4 (0.6 percent). *Keratinomyces ajelloi* was isolated from a 4-year-old male fox terrier from New Jersey with suppurative lesions on its head. *K. ajelloi*, however, has not been proved to be a pathogen.

Thirty-nine percent of the dogs under 1 year of age were positive for ringworm (table 3). This percentage decreased with age; only 1 percent were positive in dogs 7 years of age and over.

There did not appear to be a marked difference in susceptibility between the sexes; 78 (23 percent) of 342 males and 49 (17 percent) of 281 females were positive.

The data on breed group and age were too scanty to determine definite differences in susceptibility to ringworm; however, the data indicated that all breed groups were involved. Breeds were grouped according to the American Kennel Club classification. In the groups aged 1 and 2 years, the percentages positive were quite similar, possibly indicating that the breed of the animal is not an important factor in susceptibility to infection.

Twenty-two (14 percent) of 152 dogs cultured in the spring were positive, 43 (19 percent) of 227 cultured in the summer, 35 (22 percent) of 159 cultured in the fall, and 27 (26 percent) of 103 cultured in the winter. January was the peak month, with 10 (30 percent) of the 33 cultures positive.

Only 14 (11 percent) of the 127 canine cases of ringworm were found in rural areas. Six (7.7 percent) of the *M. canis* cases and 8 (17.3

Figure 2. Distribution of 46 outbreaks of suspected cases of ringworm in man associated with cases of ringworm in dogs and cats, August 1953 to September 1955.

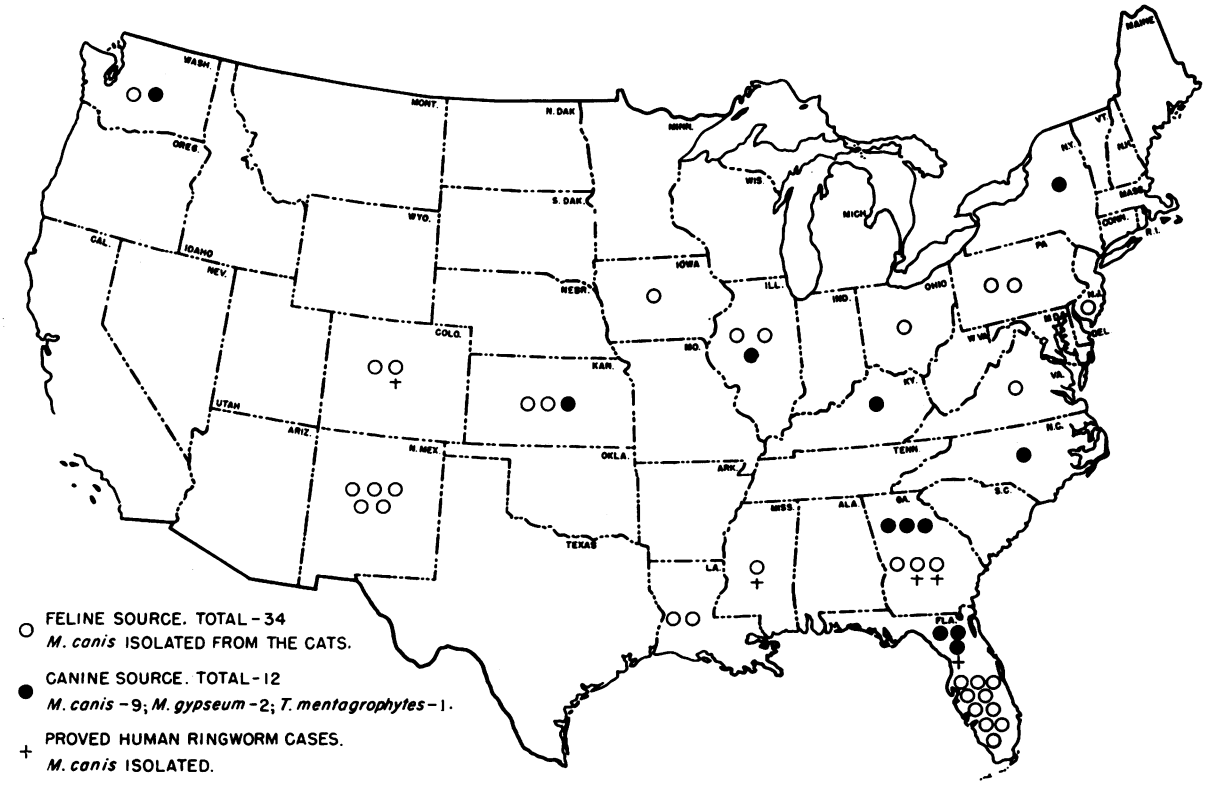


Table 3. Age distribution of 641 dogs infected with ringworm

Age (years)	Number examined	Positive	
		Number	Percent
Under 1	181	71	39
1–2	171	39	23
3–4	120	11	9
5–6	69	5	7
7 and over	79	1	1
Unknown	21	0	0
Total	641	127	20

percent) of the *M. gypseum* cases were in rural areas.

Outbreaks of ringworm among groups of dogs were not common. Only one *M. canis* outbreak and two *M. gypseum* outbreaks were found in this study. All of the outbreaks occurred among litter mates.

Infections in Cats

Outbreaks of ringworm among cats were much more common than outbreaks among dogs. Ten outbreaks among cats were found in the survey; six of these occurred in breeding establishments.

Specimens of hair from 281 cats were cultured and *M. canis* was isolated from 125 (45 percent) of these. *M. canis* was the only dermatophyte isolated.

The age distribution of the cats is shown in table 4. Sixty-seven percent of the cats under 1 year of age had ringworm. Although the percentage of positive cats decreased with age, ringworm was found in cats of all ages.

There did not appear to be a marked difference in susceptibility to ringworm between the sexes. Fifty-seven (40 percent) of 144 males cultured, and 64 (49 percent) of 130 females cultured were positive. In the group under 1 year of age, 36 (68 percent) of 53 males and 34 (64 percent) of 53 females were positive. In the group aged 1–2 years, 13 (30 percent) of 44 males and 14 (34 percent) of 41 females were positive.

The data on breed and age were scanty, but there appeared to be a difference in the percentage of infections in purebred cats and in cats of mixed breed. This difference may indicate either that ringworm is apt to develop more readily among groups of cats confined in breeding establishments or that purebred cats are more susceptible to ringworm than other types of cats.

The peak months for the occurrence of ringworm among cats were September, October, and November. However, the numbers of cases are too few to admit of any definite conclusions. An analysis of the data according to season showed that 9 (21 percent) of 43 cats cultured in the spring were positive, 38 (37 percent) of 103 cultured in the summer, 67 (71 percent) of 94 cultured in the fall, and 11 (27 percent) of 41 cultured in the winter.

Only 2 (1.6 percent) of the 125 feline cases occurred in rural areas.

Infections in Cattle and Horses

Specimens of hair from 105 cattle were cultured and *T. verrucosum* was isolated from 21 (20 percent). *T. verrucosum* was the only dermatophyte isolated. The 21 cases were from 10 States and represented 14 herds of cattle.

The age distribution of the infected cattle was as follows:

Age (years)	*Number examined*	*Positive*	
		Number	*Percent*
2 and under	45	18	40
3–4	23	1	4
5–6	20	1	5
7 and over	6	0	0
Unknown	11	1	9

The ringworm cases occurred among both dairy and beef cattle, including Hereford,

Table 4. Age distribution of 281 cats infected with ringworm

Age (years)	Number examined	Positive	
		Number	Percent
Under 1	109	73	67
1–2	88	28	32
3–4	42	16	38
5–6	16	3	19
7 and over	17	5	29
Unknown	9	0	0
Total	281	125	45

Aberdeen Angus, Brahman-Hereford cross, Jersey, Guernsey, and Holstein.

The disease occurred among cattle on the range, in feed lots, and on small dairy farms. In some outbreaks, 25 to 50 percent of the animals had skin lesions. The number of isolations reported does not represent the total number of cases of ringworm in the 14 herds.

Although there was no history of human infections among the individuals associated with the infected cattle, such transmission has been reported in the United States (*7*).

Specimens of hair from 29 horses were cultured and *T. equinum* was isolated from 3 (10 percent) : a saddle horse from Florida, a Tennessee walking horse from Ohio, and a thoroughbred horse from New Jersey. A recent study of ringworm of the horse by Georg and co-workers (*8*), with special reference to *T. equinum*, emphasizes that *T. equinum* is distinct from *T. mentagrophytes.*

Infections in Captive and Wild Animals

The organism most commonly isolated from captive animals was *T. mentagrophytes.* This organism was isolated from 6 chinchillas, 141 guinea pigs, and a kangaroo. *M. canis*, which appeared to be prevalent among monkeys, was isolated from 6 of 8 monkeys from Florida. *M. canis* was also isolated from one chinchilla.

Most of the specimens of hair from wild animals were obtained through a cooperative study on ringworm which was carried on with the Communicable Disease Center's Newton Field Station, Newton, Ga. Only 16 of 1,142 specimens from southern Georgia were from wild animals with skin lesions. The 1,142 specimens of hair were from 21 species of wild animals (table 2). Dermatophytes were isolated from 88 wild animal specimens (7.7 percent) from southern Georgia.

The organisms isolated from wild animals were: *M. gypseum*, *M. gypseum* (red variety), and *T. mentagrophytes.* The "red variety" of *M. gypseum* differed from the typical *M. gypseum* since the macroconidia had thicker walls and the colony developed a deep blood-red pigment in the agar. The red variety of *M. gypseum* was frequently isolated from cotton rats and field mice.

Discussion

Cats and dogs appear to be important transmitters of ringworm infection to man. Cattle are also of significance in this respect; however no evidence of human contagion from this source was found in this survey. A recent report by Torres and co-workers indicates that chickens may transmit ringworm infection (*9*).

M. canis was most commonly transmitted to man by cats or dogs. The young kitten with ringworm lesions was suspected of being the most frequent source of human outbreaks. Since there is no evidence that *M. canis* exists as a saprophyte in nature, it would appear that control of *M. canis* ringworm infections in the cat and dog would prevent *M. canis* infection in man. To accomplish this, at least two measures would be needed: (*a*) the control of breeding establishments and (*b*) the elimination of stray dogs and cats. Such a program has been developed by La Touche in Leeds, England, and has met with notable success (*10*).

The three cases of equine ringworm diagnosed in this survey were caused by *T. equinum.* This fungus is of particular interest, for hitherto it has not been recognized as a distinct species in this country. A study of equine ringworm by Georg and co-workers (*8*) has established that this organism, commonly associated with the horse, is a distinct species and should not be considered to be merely a variety of *T. mentagrophytes.*

The survey of wild animals revealed that ringworm caused by *T. mentagrophytes* is apparently common among rodents. It is interesting that these animals harbor this fungus without demonstrating any clinical signs of infection. The fact that the greatest number of infections occurred among rats which frequented barns and farm premises suggests that these animals may be a source of *T. mentagrophytes* infections in human populations in rural areas. It would not appear to be necessary for human beings to have direct contact with rats in order to acquire infection since it has been found that dermatophytes on hairs or skin scales may remain viable for many months. It is probable that certain areas of farm premises, especially feed bins and barns, may be contaminated by spores and infected hairs shed by ro-

dents. Because of their ubiquity and abundance, rodents would constitute a more likely source of human infection than the occasional infected dog or other farm animal.

Second to *M. canis*, *M. gypseum* appears to be the most common cause of ringworm among dogs in the United States. Verification of 46 cases during the 2-year period of this survey was quite surprising since this type of ringworm had previously been thought to be rare in animals. The recently acquired knowledge that *M. gypseum* is a common soil saprophyte (*11*), however, suggests that infection should be common in animals. The supposed rarity of *M. gypseum* infections is probably due to the fact that cultures are seldom made from animals suspected of having ringworm.

Summary

In a survey of domestic, captive, and wild animals for ringworm, dermatophytes were isolated from 520 (20 percent) of the 2,538 hair specimens cultured. The organisms commonly isolated were *Microsporum canis* from cats, dogs, monkeys, and a chinchilla; *Microsporum gypseum* from dogs, mice, rats; *Trichophyton mentagrophytes* from dogs, horses, chinchillas, guinea pigs, mice, rats, a kangaroo, and an opossum; and *Trichophyton verrucosum* from cattle and a burro. Data are presented concerning the frequency of skin lesions, method of diagnosis, and the epizootiological aspects of canine and feline ringworm. The results indicate that ringworm is a common disease among animals in the United States.

REFERENCES

(*1*) Menges, R. W., and Georg L. K.: Animal ringworm study. Vet. Med. 50: 293–297, July 1955.

(*2*) Georg, L. K.: The diagnosis of ringworm in animals. Vet. Med. 49: 157–166, April 1954.

(*3*) Blank, F.: Dermatophytes of animal origin transmissible to man. Am. J. M. Sc. 229: 302–316, March 1955.

(*4*) Georg, K. L., Ajello, L., and Papageorge, C.: Use of cycloheximide in the selective isolation of fungi pathogenic to man. J. Lab. & Clin. Med. 44: 422–428, September 1954.

(*5*) Cooke, W. B.: Western fungi. II. 3. Species from eastern Washington and adjacent Idaho. Mycologia 44: 245–261, March–April 1952.

(*6*) Menges, R. W., and Georg, L. K.: Canine ringworm caused by *Microsporum gypseum*. Cornell Vet. 47: 90–100, January 1957.

(*7*) Georg, L. K., Hand, E. A., and Menges, R. W.: Observations on rural and urban ringworm. J. Invest. Dermat. 27: 335–353, November 1956.

(*8*) Georg, L. K., Kaplan, W., and Camp, L. B.: Equine ringworm with special reference to *Trichophyton equinum*. Am. J. Vet. Res. In press.

(*9*) Torres, G., and Georg, L. K.: A human case of *Trichophyton gallinae* infection. A. M. A. Arch. Dermat., 74: 191–197, August 1956.

(*10*) La Touche, C. J.: The importance of the animal reservoir of infection in the epidemiology of animal-type ringworm in man. Vet. Rec. 67: 666–669, September 1955.

(*11*) Ajello, L.: The dermatophyte, *Microsporum gypseum*, as a saprophyte and parasite. J. Invest. Dermat. 21: 157–171, September 1953.

National Health Survey Launched

On May 6, 1957, interviewers in the National Health Survey began visiting selected households throughout the Nation to collect information on illness, accidents and injuries, disability, hospitalization, and medical and dental care.

The survey, which will be continuous, was authorized by the 84th Congress. The household interviewing is being done for the Public Health Service by the Bureau of the Census; it represents the first effort in 20 years to collect such facts comprehensively.

The National Health Survey is also planning methodological and special studies to collect data not obtainable through household interviewing.

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