Screening High-Yield Groups for Diabetes

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TWO MILLION or more persons in the United States are thought to have undiagnosed diabetes. Casefinding programs to identify these persons continue to be started. Many, however, are not operating at maximum efficiency even though case yields are improving (*1*). Statistics in this report demonstrate that screening well-selected groups in a given population can yield almost as many new cases as screening every person.

The type of population tested, testing techniques, and followup procedures largely determine the yield of new cases in diabetes screening programs. Many investigators have reported that:

1. Persons past middle age are more prone to develop diabetes than young persons.
2. Those with a history of diabetes in the family are likely candidates for the disease.
3. Obesity is characteristic among persons who develop diabetes.
4. Diabetes is often found among mothers of large babies.

Although in some diabetes screening programs attempts have been made to direct activities to these high-yield groups, generally speaking, large numbers of youthful non-obese persons have been tested. This practice tends to lower the yield of new cases. The aim of a screening project ought to be to find the maximum number of undiagnosed cases. Efficient use of staff, funds, and time requires that screening be limited to persons with high-yield characteristics, as in programs to control other diseases. In glaucoma screening, for example, the tonometer test is generally limited to persons over 40 years of age.

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Sources of Data

Results of testing high-yield groups for diabetes are available from various sources. This paper summarizes data, based on blood testing only, from the following sources:

1. Diabetes screening projects conducted throughout the United States in 1962 by State and local health departments as well as voluntary agencies. The Public Health Service received reports on approximately 300,000 screenees. Information on age was available on 176,000 persons.
2. Individual case reports sent to the Public Health Service on some 22,000 persons screened in 1963 in Pittsburgh and Minneapolis, and in Maine, Virginia, and Wyoming. Age and history of diabetes in the family were reported on all of these.
3. Federal employee health program, Division of Hospitals, Public Health Service, diabetes screening program, 1962. Screening of Federal employees is a cooperative endeavor conducted by the Federal employee health program and the diabetes and arthritis program, Division of Chronic Diseases, Public Health Service. Most of the data are on white-collar employees screened in Washington, D.C., Denver, Colo., Boston, Mass., Kansas City, Mo., Belle Mead, N.J., New York City, and Dallas, Tex. Information was available on age (age range 17–73 years), weight status, history of diabetes in the family, and history of parentage of large babies for all 8,980 employees tested in 1962.

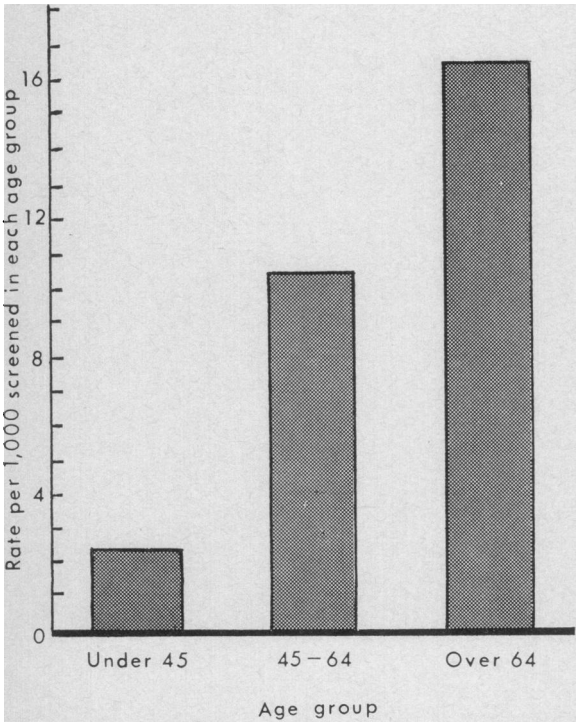
4. Project for screening relatives of diabetics, conducted in five Florida counties, 1958–59, by the Florida State Board of Health in cooperation with the Public Health Service (*2*).

5. Diabetes study in Franklin County, Ohio, in 1961–63, of 851 parents of large babies and a control group of 858 other parents. Conducted by the Ohio Department of Health in cooperation with the Public Health Service (*3*).

Data in this paper are presented primarily in terms of yield—the number of new cases of diabetes per 1,000 persons screened. The term "new cases" includes only those referred screenees whose physicians have made a diagnosis of diabetes.

Results presented are those obtained in operating programs. Yield is influenced by many variables. It is determined in part by screening techniques used. Some procedures will be more successful in helping find new cases of diabetes than others. Yield is also affected by the intensity of followup of screenees with positive test results who are referred to physicians for diagnosis. It was not possible in these projects to measure the impact on case yield of such variables.

Figure 1. New cases of diabetes per 1,000 among 176,000 screenees, by age group, fiscal 1962



SOURCE 1: Diabetes screening activity reported to the Public Health Service.

Levels of yield reported for various sets of data differ. The Federal employee health program project combines results of blood testing 2 hours after a glucose loading, results of quantitative tests, results of retesting screenees with positive reactions before referral, and thorough followup procedures. Therefore yields are high, and the resulting data are useful for analysis.

In this report we are not concerned, however, with the level of case yields but in the comparison of yields for various population groups within given projects. Comparisons of these data show that persons over 40 years of age are the most rewarding group to screen. If, in addition, those who are under 40 and have a family history of diabetes are screened, essentially the same number of undiagnosed cases of diabetes will be found as by screening the entire population. With these two criteria most diabetic parents of large babies and obese persons with diabetes will also be found.

Age

Age data reported for 176,000 screenees from our first source indicate the impact of aging on the development of diabetes. While only 2.4 new cases per 1,000 persons were discovered among screenees under the age of 45 (fig. 1), the rate was 5 times higher among persons 45 or older—11.4 per 1,000. The case-yield rate for the age group 65 or over was 57 percent higher than for the group 45–64, or 16.5 per 1,000 for the group 65 or over and 10.5 for the group 45–64. The age grouping in figure 1 conforms, for comparative purposes, to that generally used in publications of the National Center for Health Statistics, Public Health Service. This figure demonstrates the dramatic increase in diabetes with age.

Data on the 22,000 screenees from source 2 also show a high rate of diabetes among older persons. Among screenees 40 or older, the rate of new cases was 10 times that in the group under 40—6.4 per 1,000 compared to 0.6 per

1,000. At ages 60 and over, the rate was 6 times that at ages 40–49 and 2½ times that at ages 50–59.

Data from source 1 clearly illustrate the efficiency of screening older populations. Thirty-seven percent (64,611) of the 176,000 screenees for whom age data were available were 45 years of age or over. This older group yielded 73 percent (739) of the new cases. In contrast, the 63 percent (111,724) of the screenees who were less than 45 accounted for only 27 percent (268) of the new cases of diabetes.

Source 1 data show even more dramatically the low yield among the young. Only 1 new case of diabetes was found in each 5,000 screenees under the age of 20. Conversely, among persons 20 years of age or older, 1,002 new diabetics were found, 99.5 percent of the total discovered, or 33 in each 5,000 persons screened. These results emphasize the wisdom of defining the population to be screened.

Family History of Diabetes

Blood relatives of diabetics have a higher risk of developing the disease than blood relatives of nondiabetics. The risk increases if there is diabetes on both sides of the family. Thus, persons with a family history of diabetes are a primary high-yield group.

Among the 22,000 screenees from source 2, for all of whom diabetes in the family was reported, the rate of new cases found was about double that among the screenees without a family history of the disease.

Similarly, data from the Federal employee project (source 3) show a higher percentage of diabetes among persons with a family history of the disease. New cases of diabetes were 2½ times more prevalent (23.0 per 1,000 screened) among Federal employees who reported diabetes in the family than among those who did not (9.4 per 1,000 screened). There was no difference in the age distribution of these two groups. When 1 or both parents were reported as diabetic, the rate of new diabetes was 31.5 cases per 1,000 screened. The rate was 27.0 if a brother or sister reportedly had diabetes; 9.3 if a grandparent was reported as diabetic.

In the diabetes project in Florida a few years ago (source 4), blood relatives of a group of known diabetics were traced and given blood tests for diabetes (*2*). The known diabetics were indigents being supplied insulin without charge by the State. They were asked to list names of relatives, who then were invited to be tested for diabetes. Of those traced, about one-half responded and were tested.

Among the respondents the diabetes rate of previously known and new cases was two and one-half times greater than that in the general population. The rate was 41.0 per 1,000 relatives screened, compared with the U.S. prevalance rate of 17.1 per 1,000 population (*3*, *4*).

The rate of new cases among the Florida relatives also underscores the high yields among persons with a family history of diabetes. It was 21.1 per 1,000 relatives screened, compared with an estimated prevalence rate of 8.1 per 1,000 population for undiagnosed diabetes in the United States (*3*, *5*, *6*).

Weight Status

Obesity appears to be a strong precipitating factor in triggering the onset of diabetes, especially after middle age. Obesity is reported to precede diabetes in 85 percent of the diagnosed cases. Some consider obesity second only to heredity as an activating factor in development of the disease (*7*).

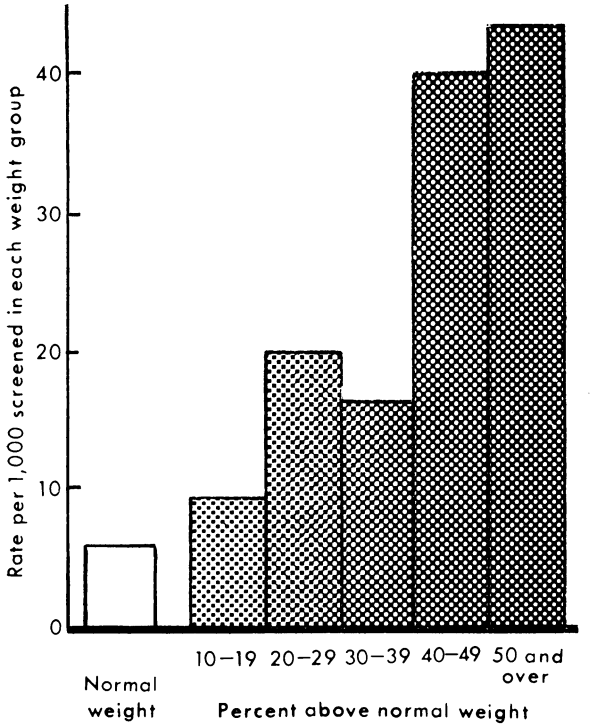
Results of diabetes screening programs demonstrate the strong relationship between obesity and new cases. Among obese Federal employees (source 3), for example, there were 16.5 new cases per 1,000 screenees. Among screenees of normal weight, the rate was 6.2 per 1,000. Furthermore, among overweight employees, rates rose as weight increased. Twenty new cases per 1,000 screened were diagnosed among those 20–29 percent overweight (fig. 2). The rate doubled to 40 per 1,000 among those 40–49 percent overweight. And, among those overweight by 50 percent or more, the rate was 43.1 per 1,000.

The weight criteria used are adapted from tables prepared by the Metropolitan Life Insurance Company. Establishment of desirable weights was based on the lowest mortality experience of males and females by height and weight measurement and not on average weight by sex.

History of Large Babies

Some investigators report an apparent relationship between birth of large infants and later development of diabetes by the parents. In the study in Franklin County, Ohio (source 5), 851 parents of large babies and a control group of 858 other parents were asked to cooperate in a diabetes study 3 to 16 years after their large babies were born (*3*). In this Ohio study, no significant relationship was found between births of large babies and development of diabetes in the fathers. But diabetes was found to be seven times more prevalent among women who had given birth to a baby weighing 9 pounds or more than it was among women who had borne babies weighing less than 9 pounds. These rates were 41.1 per 1,000 among women whose babies weighed 9 or more pounds and 5.8 per 1,000 among those with babies weighing less than 9. Rates were higher in each higher birth-weight group. Among mothers with babies weighing 7 pounds to 7 pounds 15 ounces, the rate was 2.4 per 1,000; among those with babies weighing 8 pounds to 8 pounds 15 ounces, the rate was 9.2; among mothers with babies weighing 9 pounds to 9 pounds 15 ounces, the rate was 23.1; and among those with babies weighing 10 pounds and over, the rate was 86.1.

Figure 2. New cases of diabetes per 1,000 among 8,980 screenees, by weight status, fiscal 1962



SOURCE 3: Basic data from diabetes screening project, Federal employee health program, Division of Hospitals, Public Health Service.

In 1963 information on birth history of large babies was collected in the diabetes screening program for Federal employees. Results show higher diabetes rates among women who had given birth to babies weighing 9 pounds or more than among women who had not. Whether or not there was a history of diabetes in the family, new cases were found more frequently among obese women who had borne large babies than among those who had not.

Of the female employees who were tested and answered the question on birth weight, 236 (6 percent) reported the birth of a large baby. Six of these women were diagnosed for the first time as diabetics. At time of screening, all 6 were past 40 and overweight.

Of the male employees who were tested and answered the question on birth weight, 329 (8 percent) reported they had fathered a large baby. Seven new cases of diabetes were diagnosed in these 329 men. Four of the 7 new diabetics were 40 or older; 3 of these 4 were overweight. Of the 3 men under the age of 40, 1 was overweight with diabetes in his family, 1 was of normal weight with a family history of diabetes, and 1 was of normal weight without a family history of diabetes.

Therefore, 12 of the 13 diabetic parents of large babies would have been identified by means of only two criteria—age 40 or older or under 40 with a family history of diabetes.

The case yield for Federal employees who reported parentage of a large baby was 23.0 per 1,000 persons screened, compared to a rate of 14.2 for those who said that they had never been the parent of a large baby.

Combinations of Characteristics

Weight status and age. In presenting the combinations of characteristics of high-yield groups, we are not looking at cause and effect but rather at the case yield that can be obtained.

Figure 3. New cases of diabetes per 1,000 among 8,980 screenees, by weight status and age group, fiscal 1962

SOURCE 3: Basic data from diabetes screening project, Federal employee health program, Division of Hospitals, Public Health Service.

For instance, increasing weight along with advancing age appears to be a red flag of warning to look for diabetes.

Among Federal employee screenees (source 3), new case rates for most age groups were two to three times greater for those who were overweight than for screenees of normal weight (fig. 3). Rates not only increased with each older age group, but the rise was much more rapid among overweight persons. Rates reached 48.3 per 1,000 at age 60 or older. For persons 40 or older, the rates per 1,000 screened were 22.3 among the overweight and 9.8 among persons of normal weight.

Family history of diabetes and age. When a family history of diabetes is examined in relation to age, the yield of new cases at all age levels is much higher among persons with a family history of diabetes than among those without such a family history (fig. 4). Federal employee screenees 60 or older (source 3) who had a family history of the disease yielded 76.9 new cases per 1,000.

Obesity and family history. With or without a history of diabetes in the family, those who were overweight among the Federal employee screenees (source 3) tended to have more diabetes than persons of normal weight. It should be noted, however, that persons who were obese and had diabetes in the family showed even higher rates.

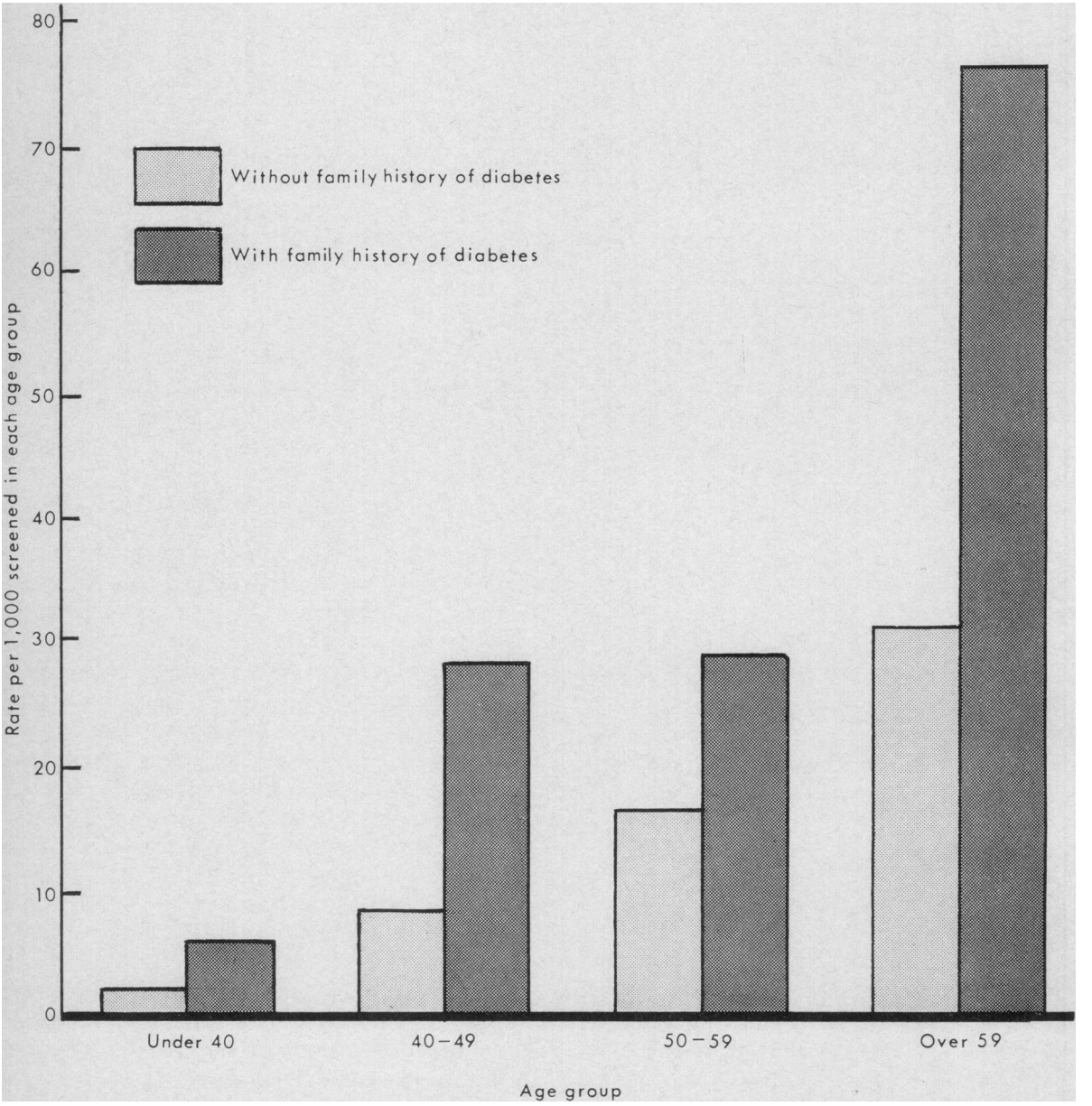
Selection of Screenees

The table presents data on yield for three of the screenee characteristics that we have discussed: age, weight status, and family history of diabetes. In this table, data from the Federal employee screening program (source 3) are used, since this project has produced high case yields and provides detailed information on each screenee.

A striking result shown in the table is that no new cases of diabetes were found among Federal employee screenees under the age of 40 who were of normal weight and without a family history of diabetes. This group comprised 14 percent of the population screened. Among those under 40 and overweight but who had no family history of diabetes, the rate was only 3.4 per 1,000. In fact, for those under 40, the rates were low for most combinations of characteristics.

The situation is different for Federal employee screenees 40 or older, except for the underweight group, among whom no new cases

Figure 4. New cases of diabetes per 1,000 among 8,980 screenees, by family history of diabetes and by age group, fiscal 1962



SOURCE 3: Basic data from diabetes screening project, Federal employee health program, Division of Hospitals, Public Health Service.

Persons screened for diabetes and new cases, by age, family history of diabetes, and weight status, diabetes project, Federal employee health program, fiscal 1962

Characteristics	Persons screened		New cases diagnosed		
	Number	Percent	Number	Percent	Per 1,000 screenees
Total screenees	8,980	100.0	108	100.0	12.0
Under age 40	3,112	34.7	7	6.5	2.2
No known family history	2,571	28.7	4	3.7	1.6
Underweight 10 percent or more	121	1.3	0	0	0
Normal weight	1,262	14.2	0	0	0
Overweight 10 percent or more	1,188	13.2	4	3.7	3.4
Family history of diabetes	541	6.0	3	2.8	5.5
Underweight 10 percent or more	33	.4	0	0	0
Normal weight	237	2.6	2	1.9	8.4
Overweight 10 percent or more	271	3.0	1	.9	3.7
Age 40 or over	5,633	62.7	100	92.6	17.8
No known family history	4,677	52.0	69	63.9	14.8
Underweight 10 percent or more	113	1.3	0	0	0
Normal weight	1,729	19.2	15	13.9	8.7
Overweight 10 percent or more	2,835	31.5	54	50.0	19.0
Family history of diabetes	956	10.7	31	28.7	32.4
Underweight 10 percent or more	14	.2	2	1.9	[1]
Normal weight	301	3.4	5	4.6	16.6
Overweight 10 percent or more	641	7.1	24	22.2	37.4
Age, family, history, and weight not stated	235	2.6	1	.9	4.3
Persons 40 or over plus persons under 40 with family history of diabetes	6,174	68.8	103	95.4	16.7

[1] Not computed—base less than 20.

SOURCE: Basic data from Federal employee health program, Division of Hospitals, Public Health Service.

were found. The lowest rate (8.3) in the 40 or older group was among persons of normal weight with no family history of diabetes. Those 40 or older and overweight but without a family history of diabetes had a rate of 19.0 per 1,000. The rate reached 37.4 per 1,000 among those 40 or older who were overweight and had a family history of diabetes.

Now, consider in combination the two criteria: 40 or older and under 40 with a family history of diabetes. Among Federal employee screenees meeting either of these criteria, the rate was 16.7 per 1,000 screened. Screenees in the group meeting the criteria totaled 6,200; 103 new cases were found. Thus, 69 percent of the total population of Federal employees screened yielded 95 percent of the new cases. In other words, 103 of the 108 new cases would have been found by screening 6,200 persons—2,800 fewer than were actually tested. Only four diagnosed cases would have been missed. Even if only 1 criterion—age 40 or older—had been adopted, 100 (93 percent) of the new cases would have been found. Only 63 percent of the total Federal employees screened would have provided this result. These data demonstrate that when funds, time, and staff are limited, it is far better to screen those who meet these two criteria than those who do not. In such circumstances, a screening program is obligated to find the probable new cases among persons in the high-yield groups, rather than to accept, for screening, volunteers from a large population who do not meet any of the criteria. To a great extent people are stimulated to participate in screening programs through information provided by those conducting the program. Effective programing and presentation of information on high-yield characteristics should result in greater participation by the high-yield groups.

Data presented in this paper show that in diabetes screening programs consideration should be given to testing all persons past 40 and those under 40 who have a history of diabetes in the family. From the standpoint of case yield, the

two most important characteristics are age 40 or over and a family history of diabetes. The yield for those who are overweight but under 40 and not relatives of diabetics is low. Whenever such persons are tested, the case yield will be reduced. In fact, there appears to be no strong justification for screening young persons unless they show a family history of diabetes.

In large-scale screening, it is probably not worthwhile to concentrate on testing parents of large babies. When all persons are encouraged to be tested without regard to characteristics, only a small proportion of the population screened will report that they are parents of large babies. Moreover, of the screenees who say that they are parents of large babies, 76 percent would be tested anyway if the only criteria for screening were age 40 or over or less than 40 with a family history of diabetes. In the Federal employee study, 12 of the 13 new cases of diabetes discovered among the parents of large babies would have been found with these two criteria.

Since it appears that approximately one-half the cases of diabetes in this country are not diagnosed, it is essential to concentrate on screening groups that will yield the greatest number of new cases. The number of diabetes screening programs and the numbers of persons tested grows each year. The proportion of undiagnosed diabetes cases discovered each year, however, remains small. Every effort should be made to increase casefinding activities and improve casefinding techniques. Selection of susceptible population groups for testing will be an important determinant in helping to bring the 2 million undiagnosed diabetics in the United States to treatment.

Summary

New cases of diabetes are diagnosed more frequently among screenees with selected characteristics than among the general population. Data for this paper were obtained from reports of diabetes screening programs sent from all parts of the United States to the Public Health Service and from special projects where detailed information on participants' characteristics were available. Reports sent to the Service on 176,000 persons screened throughout the country in the diabetes screening programs show that case yield is highest in older populations. Reports on 8,980 Federal employees screened in various cities also show that case yields are higher in those who are older, overweight, have a family history of diabetes, or have a history of births of large babies. Data from other special projects confirm these results.

Data for the Federal employees demonstrate that in diabetes screening programs consideration should be given to testing only those over 40 and those under 40 who have a family history of diabetes. In the Federal employee screening project, the 69 percent of the total population with these characteristics yielded 95 percent of the new cases.

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