Epidemiological Researches on Diabetes Mellitus in Roumanian Urban and Rural Population

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Received: May 25, 1971, accepted: November 26, 1971

Summary. This paper presents the methodology and the results of screening for *Diabetes mellitus* in large population groups. The investigation consisted of two phases: the detection of glycosuria and blood sugar level 2 h after on oral glucose load; and afterwards, the performance of GTT on people with blood sugar levels above the limits defined as normal for each age group. — The screening of 1314 subjects from a rural population and 7113 from an urban population, between 25 and 65 years of age indicated a prevalence of *Diabetes mellitus* of 1.44% and 3.7% respectively. This estimate includes diabetics already known to a special medical centre. — 74.5% of the urban population and 88.7% of the rural population were included in the screening. — Obesity was found in 51% and 69% of the newly found urban and rural diabetics, respectively. In 2.15% of the group, glycosuria was found with normal blood sugar levels during GTT, suggesting that this group should be specially recorded and subjected to periodical survey. — Screening for *Diabetes mellitus* solely by glycosuria testing is both inadequate and erroneous.

Recherches épidémiologiques concernant le diabète sucré dans la population urbaine et rurale de la Roumanie

Résumé. Les auteurs exposent la méthodologie et les résultats obtenus dans le dépistage du diabète sucré parmi de larges groupes de population. — L'exploration a été effectuée en deux phases: la glycosurie et la glycémie prise deux heures après la charge en glucose et après l'exploration par le test du GTT chez des sujets ayant des taux de glycémie dépassant les limites définies comme normales pour chaque groupe d'âge. — Chez un groupe de 1314 personnes parmi la population rurale et 7113 parmi la population urbaine, âgées de 25 à 65 ans, l'incidence du diabète sucré a été respectivement de 1.44% et de 3.7%. Dans le calcul final on a considéré aussi les diabétiques déjà en traitement dans un centre médical spécial. Des investigations plus approfondies ont été faites sur 74.5% des malades du milieu urbain dépistés et sur 88.7% des malades provenant du milieu rural. — L'incidence de l'obésité parmi les diabétiques dépistés a été de 51% dans la population urbaine et de 69% dans la population rurale. — A part

les cas de diabète sucré, les recherches en masse ont montré une proportion de 2.15% de glycosurie pour une glycémie normale lors du GTT, ce qui suggère que cette catégorie de malades devrait être recensée dans un centre médical et soumise à un contrôle périodique. — En même temps on a démontré que la méthode de dépistage du diabète sucré seulement d'après la glycosurie est insuffisante et erronée.

Epidemiologische Studien über den Diabetes mellitus in der rumänischen Stadt- und Landbevölkerung

Zusammenfassung. Es werden die Methoden und Resultate bei der Aufdeckung von Diabetikern in großen Bevölkerungsgruppen dargelegt. Die Untersuchungen erfolgten in zwei Teilen. Zunächst wurden der Harn- und Blutzucker zwei Stunden nach einer Glucosebelastung ermittelt. Später wurden bei den Personen mit im Vergleich zu den Normalwerten ihrer Altersgruppe erhöhten Blutzuckerwerten detailliertere Glucosetoleranzteste durchgeführt. — In einer Gruppe von 1314 Personen einer Landbevölkerung und in einer Gruppe von 7113 Personen einer Stadtbevölkerung zwischen 25 und 65 Jahren war die Häufigkeit des Diabetes 1.44% bzw. 3.7%. In der Endrechnung wurden schon bekannte Diabetiker, die in Diabeteszentren behandelt wurden, mit eingerechnet. An 74.5% der Stadtbevölkerung und 88.7% der Landbevölkerung wurden weitere Untersuchungen angeschlossen. Die Häufigkeit der Übergewichtigkeit unter den neu entdeckten Diabetikern lag bei 51% in der Stadt- und bei 69% in der Landbevölkerung. Neben den Diabetikern ergaben die Massenuntersuchungen in 2.15% der Fälle eine Glykosurie bei normalen Blutzuckerwerten während des Glucosetoleranztestes. Diese Gruppe von Patienten benötigte eine ständige Überwachung. — Gleichzeitig wurde festgestellt, daß die Aufdeckung von Diabetikern allein mit dem Harnzuckernachweis unzureichend und fehlerhaft ist.

Key words: Diabetes mellitus, epidemiology of diabetes, obesity, renal glycosuria, prevalence of diabetes, prevalence of obesity.

There is a conspicuous and alarming growth of morbidity, due to degenerative chronic diseases, among which *diabetes mellitus* is of great importance. Early diagnosis is one of the most important prophylactic factors of these conditions. For this purpose, a systematic detection campaign carried out on large groups of the population can be an efficient method; it should also permit accurate evaluation of morbidity rates for the whole population, with implications affecting the organisation of mass prophylaxis.

In the determination of the morbidity rate of

diabetes mellitus two principal methods of detection have been applied [1]:

- a) The investigation of postprandial glycosuria, generally followed by subsequent glucose tolerance test (GTT) in the suspect persons, and
- b) Investigation of postprandial blood sugar level, generally followed by a test for glycosuria.

The International Diabetes Federation recommends that population investigations for diabetes should be carried out in the following manner: [7, 16].

1. The determination of blood sugar and urine

levels 2 h after a meal which must contain at least 50 g carbohydrate.

2. The performance of a complete glucose tolerance test in the persons whose initial tests suggest the possibility of diabetes. This investigation should be carried out in all the subjects having glycosuria as well as a blood sugar level of 130 mg/100 ml or more (Hagedorn-Jensen).

Most of the researches carried out with the first method (a) (1930–1950) showed a relatively low morbidity rate [3, 4, 5, 6,].

Such an epidemiological study was also made in Roumania in 1962. This showed that in Bucharest, the prevalence rate, at that time, was estimated at about 1.1% [15, 16]. The method of active detection, based on the postprandial blood sugar measurement represented an important advance. Its application began about 1950, different variants being used. By this approach a 5 to 8 times higher prevalence rate was found than by the first method [7, 8, 9, 10, 11, 12, 13, 14].

Taking into account the discrepancy between the prevalence rate estimated for Bucharest and the rising

In assessing the results of the glucose tolerance test, patterns were regarded as pathological when one of the following three values was abnormal: (1) fasting blood sugar over 120 mg/100 ml, (2) blood sugar values in a GTT exceeding 160 mg/100 ml after one hour, or (3) exceeding 130 mg/100 ml 2 hours after the ingestion of glucose.

Results

In the initial screening 75 persons, representing 5.7% of the total number of the investigated subjects, were found to have blood glucose values over 130 mg/100 ml, two hours after glucose load. All these 75 subjects were subsequently submitted to G.T.T. in the laboratories of the Clinic of Metabolic Diseases and Nutrition. Abnormal patterns as defined above were obtained in 1.44%, of the original population, thus exceeding the proportion found for urban areas (Bucharest) in 1962, (Table 1). This investigation was the first to be carried out in Roumania, with the method of ingestion by the fasting subject of 100 g glucose. The results obtained illustrate the value of the method in mass detection of *Diabetes mellitus*.

Table 1. *Distribution on sex and age groups of the GTT results, of the subjects with blood sugar values over 130 mg% on the first determination. Diabetes incidence: 1.44 %*

Age group Value Sexes	17–20 yrs.				21–40 yrs.				41–60 yrs.				over 61 yrs.			
	abnormal		normal		abnormal		normal		abnormal		normal		abnormal		normal	
	men	wom-	men	wom-	men	wom-	men	wom-	men	wom-	men	wom-	men	wom-	men	wom-
Number	0	0	0	0	2	0	8	7	4	4	7	18	4	5	10	6
Total	0		0		2		15		8		25		9		16	

incidence of *Diabetes mellitus*, in the rest of the world, a new study was obviously desirable.

The present investigation was carried out separately in rural and urban area in Roumania. Sex, age and the presence of overweight were recorded and their correlation with glycosuria and hyperglycaemia after a standard glucose load was studied.

I. *Diabetes mellitus in Roumanian countryside*

This first investigation was carried out in 1968 on 1314 persons aged between 17 and 70 years (728 women and 586 men) representing 88.7% of the whole population of the village of Buda (district Ilfov). No changes in the normal nutrition of the subjects were detected during the few days which preceeded the research.

Method

Two hours after the ingestion of 100 g glucose, venous blood samples were taken for blood glucose determination (Hagedorn-Jensen's method) and urine was collected for testing by Clinistix (Ames).

II. *Diabetes mellitus in Roumanian urban areas*

A second investigation for diabetes mellitus was carried out in Bucharest in 1970 involving 7113 adults aged between 25 and 65 years. The study was limited to these groups in view of the rarity of clinically silent *diabetes mellitus* in the young and the probability of interfering factors in the old. In addition to blood sugar measurement, the range of investigation was widened to include a study of plasma lipids, obesity and arterial disease.

Method

Before the screening operation, the whole population in the involved district was informed about the aims of the investigation. Personal invitations were distributed to every family.

Blood samples were taken from the fasting subjects at 0700 h. The levels of free and esterified cholesterol, triglycerides, phospholipids and free fatty acids were subsequently estimated and lipoprotein electrophoresis carried out. Each subject then received 100 g glucose dissolved in 250 g water and two hours later a second blood sample was taken for blood sugar

measurement and urine collected for testing (Hagedorn Jensen method for blood sugar and "Clinistix" for glycosuria).

During the 2 h interval, personal data and medical histories were recorded from each individual and height, weight, blood pressure (erect and prone), examination of the fundus oculi and electrocardiogram were performed.

In the present study, only the results relating to the frequency of *Diabetes mellitus* in the investigated population by sex and age groups, will be presented.

Since the fasting and the two hour blood sugar levels vary with age [13], the maximum normal 2 h blood sugar values were established for each age group, by reference to the values obtained for 100 persons (50 men and 50 women) of each age group.

All these subjects had normal weight, and were without a personal or family history of *diabetes mellitus*, obesity and arterial hypertension, nor had they any abnormality of the retina or electrocardiogram.

The average blood sugar values were calculated for each age group, as well as the standard deviation and the upper limits for the 2 h blood sugar.

Results

The limit levels established are recorded in Fig. 1, although in this work, for the subjects aged between 25–45 years, only the values above 130 mg/100 ml were considered abnormal.

Fig. 1. Normal values for glycaemia, according the age two hours after the glucose meal

The population examined was classified according to these levels and a prevalence of 7.6% of diabetes mellitus was found among the 7113 tested persons. Among the 3287 men 8.9% and among the 3826 women 6.3% were classified as possible diabetics (Fig. 2).

The study was then concentrated on the analysis of the special group of 540 subjects, with newly found elevated blood sugar values.

These subjects were recalled and a full glucose tolerance test [2] carried out.

With the smaller number of patients, the separate consideration of each subject of the group became possible.

For the classification of abnormal tests the same criteria as those mentioned for rural areas were used.

The results obtained (Fig. 2, 3 and 4) show an incidence of *Diabetes mellitus* which varies with sex and age group, from 0.65% for men, and 0.46% for females in the age group of 25–30 years, up to 8.1% for men and 8.4 for women in the age group of 61–65 years.

Within the whole group of 7113 subjects, 332 diabetics were found representing 4.65% from the studied population. After grouping by sex, *Diabetes mellitus* was found in 192 men (5.9%) and 140 women (3.65%) (Table 2, Fig. 4).

Since 74.52% of the population between 25 and 65 years of the respective area was investigated, an estimate of the number of diabetics in the whole population became possible.

Since the number of diabetics from the investigated district was previously known and registered at the "Antidiabetic centre" from Bucharest (ACB) they

Fig. 2. Results of epidemiological investigations of diabetes mellitus depending on age
I ——— G.T.T. with one blood glucose determination (Mass investigations)
II - - - - G.T.T. after double glucose load (Duncan) (second step of investigation)

were also included in order to obtain the total prevalence of Diabetes (Fig. 3).

Thus for the whole population ranging between 25 and 65 years the prevalence of *Diabetes mellitus* was estimated to be 4.9% in the studied area.

For the population from 0–65 years the prevalence was 3.6%. In the same area there is a prevalence of 3.8% of known *Diabetes mellitus* in persons over 65 years. The number of diabetics over 65 years was added to the total number (known and discovered) of

diabetics under this age, so that the final estimated prevalence of *Diabetes mellitus* for the whole population of Bucharest became 3.7% (Fig. 6).

Compared with the previously estimated prevalence (1962) of 1.1% diabetics [15, 16] the newly defined

of the disease [12, 17, 18, 19]. These findings strongly suggest that special measures are needed for the management of the existing diabetics and the prevention of new cases with their greatly increased risk of eye, kidney and arterial diseases.

Table 2. Distribution on sex and age groups of the subjects and the incidence of diabetes mellitus after Duncan's glucose tolerance test

Age group yrs.	Total Subjects		Total Diabetics		Men Subjects		Diabetics		Women Subjects		Diabetics	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
25-30	458	100	3	0.65	238	51.9	2	0.84	220	48.1	1	0.46
31-35	598	100	12	2.00	293	49.0	5	1.72	305	51.0	7	2.30
36-40	878	100	17	1.94	388	44.3	13	3.35	490	55.7	4	0.82
41-45	1045	100	40	3.80	459	43.9	26	5.70	586	56.1	14	2.40
46-50	1088	100	55	5.00	451	42.0	36	7.90	631	58.0	19	3.00
51-55	836	100	36	4.30	368	44.0	19	5.20	468	56.0	17	3.65
56-60	1242	100	91	7.30	570	45.8	51	9.00	672	54.2	40	5.90
61-65	968	100	78	8.10	514	53.0	40	7.80	454	47.0	38	8.40
Total	7113	100	332	4.65	3287	46.2	192	5.90	3826	53.8	140	3.65

Fig. 3. Incidence of diabetes mellitus

prevalence in the same population group leads to the conclusion that, for each known diabetic person, there are two or even three unknown diabetics in the population.

This high prevalence of *Diabetes mellitus*, places Roumania, at least when the urban population is considered, among the countries with a high frequency

Fig. 4. Distribution depending on age group, and sex of the diabetes incidence

III. Correlation between Diabetes and Obesity in the Roumanian population

Because of the importance of obesity as a diabetogenic factor, overweight in the newly-found diabetic subjects was considered.

15% or more over the ideal weight (according to Broca) was taken as defining obesity and on this basis a high frequency of obesity was found, reaching 77% for certain ages (Fig. 7).

171 (51%) out of 332 newly found diabetics were obviously overweight. In the rural population, obesity was found in 69% on the tested subjects.

This fact supports the hypothesis of a diabetogenic role of obesity and raises the question of urgent controls as a prophylactic measure.

IV. Glycosuria with normal blood sugar

In addition to the people with newly-found clinical, chemical and latent *Diabetes mellitus*, glycosuria was noted 2 h after the glucose load in a high proportion of the normoglycaemic people. The group included sub-

The incidence of obesity in these subjects, assessed on the basis of criteria previously described was 27.5% (Fig. 9).

Glycosuria with normoglycaemia following a glucose load seems to indicate the existence of a separate category of disorders of carbohydrate metabolism.

Fig. 5. Incidence of diabetes mellitus

Fig. 6.

jects initially with normoglycaemia (below the upper limit established for the appropriate age group) (Fig. 1) and with normal values at the second laboratory investigation.

Glycosuria with normoglycaemia, was found in 2.15% of the whole investigated population (the percentages by sex and age are recorded in Fig. 8).

When considering *Diabetes mellitus*, this situation leads to a significant but spurious overestimate of the prevalence of the disease in the whole population. Despite its apparently benign nature, subjects with renal glycosuria should be recorded and periodically re-examined.

The detection of *Diabetes mellitus* by sole reliance

upon glycosuria, is both inadequate and erroneous. Any mass screening must include the measurement of blood sugar at the same time as testing for glycosuria, with

the individual checking of glucose tolerance in the doubtful cases.

Conclusions

— The most suitable method for mass detection of *Diabetes mellitus* is the measurement of blood sugar and the urine test for glucose two hours after an oral

Fig. 7. Percentage of Incidence for obesity by newly found diabetics (age grouping)

Fig. 8. Incidence of glucosuria by normal blood glucose, 2 h after the carbohydrate meal

Fig. 9. Incidence of obesity (%) depending on age by the subjects which showed glucosuria without hyperglycemia

glucose load, followed by individual investigation through the oral glucose tolerance test in doubtful cases.

— The application of this method in 1314 subjects in a Roumanian rural population and on 7113 persons in an urban population indicated a prevalence of *Diabetes mellitus* of 1.44%, in the rural population and of 3.7%, in the urban population.

A recent research made in München [6], found a clear prevalence of *Diabetes mellitus* in male subjects, aged under 50. This fact was already suggested by the statistical data on *Diabetes mellitus* from A.C.B., regarding this disease in Bucharest from 1942—1970.

Obesity among the newly discovered diabetics was present in 51% in the urban population and 69% in the rural one.

The study has also pointed out, that, in addition to newly found cases of *Diabetes mellitus*, 2.15% of the subjects had glycosuria with normoglycaemia and normal GTT, suggesting that this group deserves special attention as a separate category.

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