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Prevalence of Retinopathy and Its Associated Factors in Type-2 Diabetes Mellitus Patients Visiting Hospitals and Diabetic Clinics in Faisalabad, Pakistan

Muhammad Hassan, Mobeen Akhtar* and Naeem Akhtar
Department of Zoology, G.C. University, Faisalabad (MH, MA) and Allied Hospital, Punjab Medical College Faisalabad (NA)

Abstract.- Five hundred patients, visiting the government hospitals and diabetic clinics at Faisalabad were examined for retinopathy and their blood samples were analyzed for HbA_{1c} and lipid profile. Retinopathy was found 41.4% and its prevalence was found higher in patients with HbA_{1c} >8%. Besides that the age of patients, duration of diabetes, history of hypertension and smoking status were found to be significantly ($P<0.05$) associated with the prevalence of retinopathy in the diabetic patients. It was concluded that the prevalence of diabetic retinopathy was higher in patients with poor glycaemic control, duration of diabetes and history of hypertension.

Key words: Retinopathy, glycosylated haemoglobin, $HbA_{1c,}$ diabetes mellitus type-2.

INTRODUCTION

Diabetes mellitus (DM) is a metabolic syndrome characterized by hyperglycaemia due to absolute or relative deficiency of insulin. Lack of insulin affects the metabolism of carbohydrate, protein and fat, and causes a significant disturbance of water and electrolyte homeostasis. Death may result from acute metabolic decompensation, while long-standing metabolic derangement is frequently associated with permanent and irreversible functional and structural changes in the cell of the body, with those of the vascular system being particularly susceptible. It damages the vessels and the basement membranes, causing impaired delivery of nutrients and hormones to the tissues, resulting in tissues damage. The most affected sites are the retina, renal glomerulus and the nerve sheah (Edwards *et al.*, 1991).

Diabetic retinopathy is the most common cause of legal blindness in adults under the age of 65 in most countries (NIH, 1985). Insulin deficiency results in the elevated blood glucose level that is accompanied by and causes structural, physiologic and hormonal changes that affect retinal capillaries, causing the capillaries to become functionally less competent (Shimizu *et al.*, 1981; Niki *et al.*, 1984; Bresnick, 1989).

The incidence of retinopathy increases alongwith the duration of diabetes and 60 percent of patients with type-2 diabetes have retinal changes after 20 years of the disease. The first signs of retinopathy are microaneurysms (minimal retinopathy), which are followed by haemorrhages and lipid exudates (background retinopathy), cotton-wool spots and venous reduplication (preproliferative retinopathy). Non-enzymatic glycation and changes in growth factor profiles cause deposition of further extracellular matrix material along the basement membranes of small vessels. Also, an excess of glucose activates the polyol pathway which causes accumulation of sorbitol in the lens and is accompanied by cataracts (Esperance *et al.*, 1990; Kinoshita *et al.*, 1990). The present paper describes the prevalence of retinopathy and its associated factors in type-2 diabetes mellitus as determined in 500 patients visiting Government hospitals and private clinics at Faisalabad, Pakistan.

MATERIALS AND METHODS

A total of 500 patients with type-2 diabetes belonging to different socio-economic groups and attending the Government Hospitals (District Headquarter Hospial and Allied Hospital) and private clinics in Peoples Colony and Hajwary Town in Faisalabad for a follow-up visit during the study period from November, 2004 to Decmber, 2005 were

* Corresponding author: mianmobeenakhtar@gmail.com
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included in this study.

Blood samples from all the diabetic patients with type-2 were analysed for glycosylated Haemoglobin (HbA_{1c}) according to Bisse and Abraham (1985), cholesterol, according to Artiss and Zak (1997), triglycerides according to Cole *et al.* (1997), high-density lipoprotein cholesterol (HDL-C) according to Burstein *et al.* (1970) and low density lipoprotein cholesterol (LDL-C) according to Friedewald *et al.* (1972).

Patient's medical examination

All the diabetic patients included in this study were examined by registered practitioners for retinopathy. Other details such as gender, age, education, and socio-economic status, family history of diabetes, duration of diabetes, smoking status, blood pressure, weight, height, exercise status, wasit girth and hip girth of all diabetic patients were recorded on a structural proforma. The data was subjected to statistical analysis (chi-square test) in order to determine the relationship among the various risk factors and complications of diabetes.

RESUTLS AND DISCUSSION

Out of the 500 diabetic patients, 207 (41.4%) were observed with complication of retinopathy, while 293 (58.6%) showed no indication of retinopathy. Table I shows characteristics of all 500 persons suffering from diabetes mellitus type-2 included in this study. Table II shows results of biochemical tests of all diabetic patients included in this study. Prevalence of retinopathy in all diabetic patients included in this study with reference to different associated factors is shown in Table III. Results of chi-square test showed that age of patient, duration of diabetes, history of hypertension and smoking status are significantly ($P<0.05$) associated with the prevalence of retinopathy in diabetic patients.

Sex wise prevalence

In the present study, a high sex specific prevalence was reported in females in type-2 diabetes mellitus. Within type-2 diabetes mellitus 43.2% were males and 56.8% were females. In agreement with the present study, previously Shera *et al.* (1999) have estimated that the type-2 diabetes was more in females (11.1%) than in males (9.4%) in

Table I.- Characteristics of 500 persons with type-2 diabetes mellitus.

Variable	Total (n=500)	
	No.	%
Sex		
Female	284	56.8
Male		
Age (Years)		
≤49	145	29.0
50-59	187	37.4
60-69	137	27.4
≥70	31	6.2
Education		
Gragaute/Postgraduate	88	17.6
Higher Secondary	84	16.8
Secondary	91	18.2
Primary	59	11.8
Illiterate	178	35.6
Monthly income (Pakistani Rupees)		
>10,000	90	18.0
5,000-10,000	115	23
<5,000	181	36.2
Not mentioned	114	22.8
Duration of diabetes		
1-5 years	206	41.2
>5 years	294	58.8
History of smoking		
Never smoked	418	83.6
Past smoker	38	7.6
Current smoker	44	8.8
Exercise status		
Regular	173	34.6
Irregular	327	65.4
History of hypertension		
Yes	196	39.5
No	304	60.8
Body mass index (BMI)		
≥25	331	66.2
<25	169	33.8
Waist to hip ratio (WHR)		
More	417	83.4
Less	83	16.0

Table II.- Biochemical tests of 500 diabetic patients.

	No. of patients	Percent
HbA1c		
Good glycemic control <7%	248	49.6
Acceptable 7-8%	93	18.6
Poor glycemic control >8%	159	31.8
Cholesterol		
Desireable ≤200 mg/dl	119	23.8
Borderline 200-240mg/dl	136	27.2
High risk >240 mg/dl	245	49.0
Total triglycerides		
Desireable ≤200 mg/dl	121	24.2
Borderline 200-240mg/dl	114	22.8
Elevated/high risk>240 mg/dl	265	53.0
HDL-cholesterol		
Desireable/normal >40 mg/dl	61	12.2
Borderline 30-40mg/dl	54	10.8
High risk >30 mg/dl	385	77.0
LDL-cholesterol		
Desireable ≤130 mg/dl	128	25.6
Borderline 130-160mg/dl	79	15.8
High risk <240 mg/dl	293	58.6

the rural areas of NWFP. Rosenbloom *et al.* (1998) also reported that females were more frequently affected than the males by non insulin dependent diabetes mellitus (NIDDM) in Native American and African-American youth. Female preponderance in prevalence of diabetes mellitus in Pakistani patients has also been reported previously (Shera *et al.*, 1999b). In a survey of consecutive households in a relatively prosperous and a poor area in Karachi, it was documented that diabetes was more common in females in both populations (Hameed *et al.*, 1995).

Age wise prevalence

Diabetes is known to be increasing in prevalence and incidence among the elderly (Walker *et al.*, 1997, Black *et al.*, 1999, Allessandro *et al.*, 1999). In the present study, it was found that diabetes mellitus type-2 was more prevalent in age group 50-59 years followed by patients of age group ≤49. Least prevalence was found in patients with age 70 yers or more. It is due to the fact that diabetic patients rarely reach upto te age of 70 years or more. Due to the same reason only 31 out of 500 diabetic patients were of 70 years or more. Similarly, in a survey of relatively prosperous and a poor area in Karachi, Pakistan a maximal prevalence of 25% was seen in the affluent community aged 55-64 years (Hameed *et*

Table III.- Prevalence of retinopathy in 500 diabetic patients and associated risk factors.

Vaiables	Complication present (n=207)		Complication not present (n=293)	
	No.	%	No.	%
Age in years				
≤49	39	18.8	106	36.2
50-59	77	37.2	110	37.5
60-69	65	31.4	72	24.6
≥70	26	12.6	5	1.7
Duration of diabetes				
1-5	70	33.8	136	46.4
>5 years	137	66.2	157	53.6
Exercise status				
Regular	76	36.7	97	33.1
Irregular	131	63.3	196	66.9
Hypertension				
Yes	131	63.3	65	22.2
No	76	36.7	228	77.8
Body mass index BMI				
≥25	134	64.7	197	67.2
< 25	73	35.3	96	32.8
Waist to hip ratio (WHR)				
More	172	83.1	245	83.6
Less	35	16.9	48	16.4
History of smoking				
Never smoked	141	68.1	277	94.5
Past smoker	27	13.1	11	3.8
Current smoker	39	18.8	5	1.7

"Regular exercise" means if a person was doing at least 20 minutes exercise or at least 30 minutes brisk walk four or more times per week (Khuwaja *et al*., 2004).
Hypertension was defined as the presence of systolic blood pressure ≥140 mmHg and diastolic blood pressure of ≥90 mmHg or a known hypertensive on treatment (Shera *et al*., 2004). BMI = Weight in kilograms/(Height in meters)2. Those who had BMI ≥25 were labeled "high BMI" (Khuwaja *et al*., 2004) WHR) was calculated by = Waist girth in c.m/Hip girth in c.m. The normal figure for males was >0.95 and for females <0.85 (Alberti and Zimmet, 1998). Responders who were currently smoking and smoked at least 100 cigarettes in their life time were defined as current smokers (Kujwaja *et al*., 2004).

al., 1995). In another study conducted in rural town of Shikarpur in Sindh Province, Pakistan, it was reported that prevalence of diabetes mellitus rose with age (Shera *et al.*, 1995).

Literacy rate related incidence

In this study, it was found that about one third (35.6%) of diabetic patients with complications were illiterate. This finding is supported by a multi-center cross-sectional study conducted in Karachi (Khuwaja *et al.*, 2004) that had found 31% prevalence of diabetic complications in illiterate patients. One possible reason for this overall high prevalence in illiterate diabetic patients is that they did not know the importance of proper management of diabetes mellitus, optimal glycemic control and imbalance nutrition.

Socioeconomic status

The role of socio-economic status in promoting diabetes management and improved glycemic control is a little-explored area. Lower income is one of the problems for proper glycemic control in black children with diabetes (Delamater *et al.*, 1999). Present study also supports the above findings because lower income was one of the problems for maintaining good glycemic control in most of the patients with poor glycemic control.

Duration of disease

The duration of diabetes is considered an important factor in the development of compilations (Knuiman *et al.*, 1986). In our study, 58.8% patients had diabetes and associated complications for more than five years. The findings of present study are supported by a population based cross-sectional study in Pakistan, in which highest prevalence of complications was found in persons having diabetes for more than 13 years (Hashim *et al.*, 2004). Present study indicates that 18.8% of individuals who are current smokers have retinal complications as compared to 13.1% of individuals who were past smokers.

Hypertension

Hypertension is a well recognized factor associated with the development of complications especially cardiovascular and cerebrovascular diseases, and this risk increases further when it is associated with diabetes (Spanheumer, 2001). The present investigation documented that 39.2% of patients with type-2 diabetes have history of hypertension. The present findings are also supported by a cross-sectional survey in Sindh and Baluchistan provinces (Shera *et al.*, 1995, 1999a). Results from these landmark intervention studies demonstrate that the complications of diabetes can be prevented or delayed by controlling hypertension (UKPDS, 1998, 2000).

Physical and biochemical factors

In present study, it is found that lack of physical activity, greater body mass index and greater waist to hip ratio are more common in diabetic patients with complications. Present findings are supported by a number of studies which have shown that lack of physical activity, greater body mass index and greater waist to hip ratio play a significant role in the development of complications in patients with diabetes type-2 (Wing *et al.*, 1998; Williamson *et al.*, 2000).

HbA_{1C} levels are a valuable adjustment to glucose determinations in individuals with diabetes mellitus, providing much more reliable determinations of glucose. Numerous studies have shown that diabetes related compilations may be reduced by the long-term monitoring and tight control of blood glucose level (DCCT, 1993; Tietz, 1999). In the present study 159 diabetic patients having complications show poor glycemic control (HbA_{1C} >8%). These finding are supported by Goldstein *et al.* (1995) and guidelines given in the clinical monitoring of diabetic patients (ADA, 1998). Suomen (1995) has also reported that HbA_{1C} >8% is associated with poor glycemic control and development of diabetic complications. In present investigation, it was found that diabetic patients with complications showed high level of cholesterol, triglycerides, LDL-chlesterol and lower levels of HDL-cholesterol. This lipid profile is an important index to assess the metabolic control in diabetic patients (Davidson, 2002). A number of epidemiological studies support the present finding that low HDL-cholesterol concentrations, high concentrations of cholesterol, triglycerides, and LDL cholesterol are associated with high risk of

developing diabetic complications and poor metabolic control. Similar findings were also reported by Garcia and McNamara (1974) and Malmberg and Ryden (1988).

Retinopathy is more common and its prevalence is strongly related to the duration of diabetes, lack of exercise, hypertension and obesity/overweight (more BMI than 25 and more waist to hip ratio). In present study retinopathy was more commonly seen (41.4%) supported by the findings of Herman *et al.* (1998), who have reported retinopathy in 42% of their study subjects, contrary to findings (Ramachandran *et al.*, 1999), 23.7% retinopathy it has been reported in Indian (Morgan *et al.*, 2000), in 30.6% in spain (Zafar *et al.*, 2000) and 44.6% in Mexico (Paisey *et al.*, 1984).

Present findings show that retinopathy is strongly associated ($P<0.01$) with age of the patient, duration of diabetes, having history of hypertension, more body mass index and more waist to hip ratio. These findings are also supported by other workers (Kinoshita *et al.*, 1990, Esperance *et al.*, 1990; ADA, 1998a).

REFERENCES

ALBERTI, K.G.M.M. AND ZIMMET, P.Z., 1998. For the WHO consultation, definition, diagnosis, classification of diabetes mellitus and its complications Part 1: diagnosis and classification of diabetes mellitis. Provisional Report of a WHO Consultation, *Diabet. Med.*, **15**: 539-553.

ALESSANDRO, D., YANG, Y., ALECKI, M.M., SCOTTI, S. AND DREYFUS, J., 1999. Phenotypic characteristics of early onset autosomal dominant type-2 diabetes unlinked to known maturity onset diabetes of the young genes. *Diabet. Care*, **22**: 253-261.

AMERICAN DIABETES ASSOCIATION (ADA), 1998. Diabetic retinopathy.position statement. *Diabet. Care*, **21** (Suppl-1): S47-S49.

ARTISS, J.D. AND ZAK, B., 1997. Measurement of cholesterol concentration. In: *Handbook of lipoprotein testing* (eds. N. Rifai, G.R. Warnick and M.H. Dominiczak) AACC Press, Washington, pp. 99-114.

BISSE, E. AND ABRAHAM, B.C., 1985. New less temperature-sensitive micro-chromatographic method for the separation and quantitation of glycosylated Haemoglobins using a non-cyanide buffer system. *J. Chromatog.*, **344**: 81-91.

BLACK, S.A., JAKOBI, P.L., RUSH, R.D., DINUZZO, A.R. AND GARCIA, D., 1999. Ethnic variation in the health burden of self-reported diabetes in adults aged 75 and older. *Ethn. Dis.*, **9**: 22-32.

BRESNICK, G.H., 1989. *Background diabetic retinopathy*, Vol 2 CV Mosby, St. Louis. pp. 327-366.

BURSTEIN, M., SCHOLNICK, H.R. AND MORFIN, R., 1970. Estimation of the concentration of high-density lipoprotein cholesterol in plasma, without use of the preparative ultracentrifuge. *J. Lipid Res.*, **11**: 583.

COLE, T.G., KLOTZSCH, S.G. AND MCNAMARA, J., 1997. Measurement of triglyceride concentration. In: *Handbook of lipoprotein testing*(eds. N. Rifai, G.R. Warnick and M.H. Dominiczak) AACC Press, Washington. pp. 115-126.

DAVIDSON, M.B., 2002. *Principles and practice of medicine, Diabetes mellitus* 19th Ed. Churchill Livingstone, UK, pp. 641-688.

DELAMATER, A.M., SHAHW, K.H., APPLEGAE, E.B., PRATT, I.A., EIDSON, M., LANCELOTTA, G.X., GONZALEZ-MENDOZA, L. AND RICHTON, S., 1999. Risk for metabolic control problems in minority youth with diabetes. *Diabet. Care*, **22**: 700-705.

DIABETES CONTROL AND COMPLICATIONS TRIAL RESEARCH GROUP, 1993. The effect of intensive treatment of diabetes on the development and progression of long-term complications in insulin-dependent diabetes mellitus. *N. Engl. J. Med.*, **329**: 977-986.

EDWARDS, C.R.W., BAIRD, J.D. AND TOFT, A.D., 1991. Endocrine and metabolic disease In: *Davidson's principles and practice of medicine*. Churchill Livingston, pp. 607-698.

ESPERANCE, F.A., JAMES, J.W.A. AND JUDSON, P.H., 1990. *The eye and diabetes mellitus. Theory and practice*. Elsevier, New York, pp. 661-683.

FRIEDEWALD, W.T., LEVY, R.I. AND FREDRICKSON, D.S., 1972. Estimation of the concentration of low-density lipoprotein cholesterol in plasma, without use of the preparative ultracentrifuge. *Clin. Chem.*, **18**: 499.

GARCIA, M.J. AND McNAMARA, P.M., 1974. Morbidity and mortality in diabetes in Framingham population sixteen years follow-up study. *Diabetes*, **23**: 105-111.

GOLDSTEIN, D.E., LITTLE, R.R., LORENZ, R.A., MALLONE, J.I., NATHAN, D. AND PETERSON, C.M., 1995. Tests of glycaemia in diabetes (Technical Review). *Diabet. Care*, **18**: 896-909.

HAMEED, K., KADIR, M., GIBSON, T. SULTANA, S., FATIMA, Z. AND SYED, A., 1995. The frequency of known diabetes, hypertension and ischaemic heart disease in affluent and poor urban populations of Karachi, Pakistan. *Diabet. Med.*, **12**: 500-503.

HASHIM, R., KHALIL-UR-REHMAN, AHMED, T.A., MUSHTAQ, S., ZAFAR, L. AND ATTIQUE, M., 2004. Microalbuminuria and associate risk factor in Type 2 diabetes. *J. Coll. Phys. Surg. Pakistan*, **14**: 84-89.

HERMAN, W.H., AUBERT, R.E. AND ENGELGAU, M.M., 1998. Diabetes mellitus in Egypt: glycaemic control and microvascular and neuropathic complications. *Diab. Med.*, **15**: 1045 -1051.

KHUWAJA, A.K., RAFIQUE, G., WHITE, F. AND AZAM, S.I., 2004. Macrovascular complications and their associated factors among persons with type-2 diabetes in Karachi, Pakistan. *J. Pak. med. Assoc.*, **54**: 60-66.

KINOSHITA, J.H., DATILES, M.B., KADOR, P.F. AND ROBISON, W.G., 1990. Aldose reductase and diabetic eye complications. In: *Henberg and Rifkins diabetes mellitus* (eds. H. Rifkin. and D.J. Porte). Theory and Practice. Elsevier, New York, pp. 264-278. .

KNUIMAN, M.W., WELBORN, T.A. AND MCCANN, V.J., 1986. Prevalence of diabetic complications in relation to risk factors. *Diabetes*, **35**: 1332-9.

MALMBERG, K. AND RYDEN, L., 1988. Mycordial infaraction in patients with diabetes mellitus. *Eur. Heart J.*, **9**: 159-264.

MORGAN, C.L., CURRIE, C.J. AND STOTT, N.C., 2000. The prevalence of multiple diabetes related complications. *Diabet. Med.*, **17**: 146-151.

NATIONAL INSTITUTE OF HEALTH, 1985. National Diabetes Data Group. Diabetes in America, 1985; Diabetes data compiled in 1984. *(NIH Publication No.* 85-1468)

NIKI, T., MURAOKA, K. AND MIZU, K., 1984. Distribution of capillary non-perfusion in early stage diabetic retinopathy. *Ophthalmology*, **91**: 1431-39.

PAISEY, R.B., ARREDONDO, G. AND VILLALOBOS, A., 1984. Association of differing dietary, metabolic, and clinical risk factors with microvascular complications of diabetes: a prevalence study on 503 Mexican type II diabetic subjects. *Diabet. Care*, **7**: 428-433.

RAMACHANDRAN, A., SNEHALATHA, C., SATYAVANI, K., LATHA, E., SASIKALA, R. AND VIJAY, V., 1999. The prevalence of vascular complications and their risk factors in type-2 diabetes. *J. Assoc. Physic. India*, **47**: 1152-56.

ROSENBLOOM, A.L., HOUSE, D.V. AND WINTER, W.F., 1998. Physical activity and NIDDM in African-American. *Clin. Pediatr. Phila.*, **37**: 143-152.

SHERA, A.S., JAWAD, F., MAQSOOD, A., JAMAL, S., AZFAR, M. AND AHMAD, U., 2004. Prevalence of chronic complications and aossociated factors in type-2 diabetes. *J. Pak. med. Assoc.*, **54**: 54-59.

SHERA, A.S., RAFIQUE, G., KHAWAJA, I.A., BAQAI, S., KHAN, I.A., KING, H. AND AHMAD, K.l., 1995. Pakistan National Diabetes Survey: prevalence of glucose intolerance and associated factors in Shikarpur, Sindh Province. *Diabet. Med.*, **12**: 1116-1121.

SHERA, A.S., RAFIQUE, G., KHAWAJA, I.A., BAQAI, S. AND KING, H., 1999a. Pakistan National Diabetes Survey; prevalence of glucose intolerance and associated factors in Baluchistan province: *Diabet. Res. Clin. Pract.*, **44**: 49-58.

SHERA, A.S., RAFIQUE, G., KHAWAJA, I.A., BAQAI, S., KHAN, I.A., KING, H. AND AHMAD, K.l., 1999b. Pakistan - National Diabetes Survey prevalence of glucose intolerance and associated factors in North West Frontier Province (NWFP) of Pakistan. *J. Pak. med. Assoc*., **49**: 206-211.

SHIMIZU, K., KOBAYASHI, Y. AND MURAOKA, K., 1981. Midperipheral fundus involvement in diabetic retinopathy. *Ophthalmology*, **88**: 601-612.

SPANHEUMER, R.G., 2001. Reducing cardiovascular risk in diabetes. *Postgrad. Med.*, **109**: 26-36.

SUOMEN, D., 1995. Nuoruustyypin diabeteksen hoitosuositus. Suomen Diabetesliitto ry: n julkaisusarja, P 13.

TIETZ, N.W., 1999. *Clinical guide to laboratory tests*. 3rd Ed. Saunders Company. pp. 809-861.

UNITED KINGDOM PROSPECTIVE DIABETES STUDY GROUP, 1998. Tight blood pressure control and risk of macrovascular and microvascular complications in type-2 diabetes (UKPDS 38). *Br. med. J.*, **317**: 703-713.

UNITED KINGDOM PROSPECTIVE DIABETES STUDY GROUP, 2000. Association of systolic blood pressure with macrovascular and microvascular complications of type-2 diabetes (UKPDS 36). *Br. med. J.*, **321**: 412-419..

WALKER, E.A., BASCH, C.H., HOWARD, C.J., ZYBERT, P.A., KROMHOL, W.N. AND SHAMOON, H., 1997. Incentives and barriers to retinopalhy screening among African- Americans with diabetes. *J. Diabet. Complic.*, **11**: 298-306.

WILLIAMSON, D.E., THOMPSON, T.J. AND THUN, M., 2000. Intentional weight loss and mortality among overweight individuals with diabetes. *Diabet. Care*, **23**: 1499-1504.

WING, R.R., VENDITII, E. AND JAKICIC, J.M., 1998. Lifestyle intervention in overweight individuals with a family history of diabetes. *Diabet. Care*, **21**: 350-360.

ZAFRA, J.A., MENDEZ, J.C., NOVALBOS, J.P., COSTA, M.J. AND FAILDE, I., 2000. Chronic complications in patients with type-2 diabetes melitus cared for at a health center. *Aten. Primaria*, **25**:529-535.

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