Blood glucose control in diabetes patients seen in primary health care centers

Controle glicêmico em pacientes diabéticos atendidos em centros de atenção primária à saúde

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Keywords
Diabetes mellitus, prevention & control. Primary health care. Delivery of health care. Diabetes mellitus, metabolism. Hyperglycemia. Socioeconomic factors.

Abstract

Objective
To identify factors associated to poor glycemic control among diabetic patients seen at primary health care centers.
Methods
A cross-sectional study was carried out in a sample of 372 diabetic patients attending 32 primary health care centers in southern Brazil. Data on three hierarchical levels of health unit infrastructure, medical care and patient characteristics were collected.
Results
The frequency of poor glycemic control was 50.5%. Multivariate analysis (multilevel method) showed that patients with body mass indexes below 27 kg/m^2, patients on oral hypoglycemic agents or insulin, and patients diagnosed as diabetic over five years prior to the interview were more likely to present poor glycemic control when compared to their counterparts.
Conclusions
Given the hierarchical data structuring, all associations found suggest that factors associated to hyperglycemia are related to patient-level characteristics.

Descritores
Diabetes mellitus, prevenção & controle. Cuidados primários de saúde. Prestação de cuidados de saúde. Diabetes mellitus, metabolismo. Hiperglicemia. Fatores socioeconômicos.

Resumo

Objetivo
Identificar fatores associados à falta de controle glicêmico em pacientes diabéticos atendidos em centros de atenção primária à saúde.
Métodos
Estudo transversal em amostra de 372 pacientes diabéticos atendidos nos 32 centros de atenção primária de uma cidade do sul do Brasil. Foram coletados dados ordenados em três níveis hierárquicos: estrutura das unidades de saúde, características do processo do cuidado médico e pacientes diabéticos.
Resultados
A freqüência de falta de controle glicêmico foi de 50,5%. A análise multivariada (método multinível) mostrou que pacientes com Índice de Massa Corporal abaixo de 27 kg/m^2, em tratamento medicamentoso e com mais de cinco anos de diagnóstico de diabetes, tiveram maior probabilidade de apresentar hiperglicemia quando comparados a seus pares.

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Conclusões
Considerando a estrutura hierárquica dos dados, todas as associações encontradas sugerem que os fatores associados à hiperglicemia são relacionados a características dos pacientes.

INTRODUCTION

The association between diabetes complications and high glucose levels was postulated in the early twentieth century. Only during the last three decades, however, clinical research performed on diabetic patients directly associated hyperglycemia to the development of complications.[1] Adequate diabetes care, which includes glycemic control and early screening and treatment for end-organ damage, can prevent the appearance of severe complications. The greatest challenge, however, resides in the fact that the treatment of such a complex disease requires multiple processes and decisions which involve both healthcare providers and patients. Despite the numerous technical advances observed in diabetes control and evaluation, diabetes care remains, perhaps, the most complex chronic disease to be managed at the primary health care level.[12]

There is a lack of studies in the literature designed to assess effectiveness of care of diabetic patients who are cared by primary health care physicians. The purpose of this study was to identify factors associated to poor glycemic control among diabetic patients seen at the primary health care network (PHCN).

METHODS

A cross-sectional study was conducted in the city of Pelotas, southern Brazil, between May and December 1998. A city of 320,000 inhabitants, 30% of Pelotas' population are regular users of the PHCN. Coverage of this system reaches mainly individuals from poor social classes. The sample size was calculated to detect a 2 prevalence ratio, given a 20% prevalence of glycemic control among unexposed individuals. This prevalence was identified by a cross-sectional study performed in a primary health care facility.[2] The exposure used for calculating the sample size was compliance with the recommended diet. In the aforementioned study it was observed for one in four subjects. Assuming 80% power and a 5% significance level, it resulted in a sample of 232 diabetic patients. This was increased by 15% for confounder control, and by 15% for possible losses and refusals, leading to a total sample of 372 subjects. During the study period, the PHCN in the city's urban area comprised 32 health centers. A trained field worker visited every health center and examined all claims that would be submitted for federal reimbursement searching for registries of diabetes diagnoses. In two non-consecutive weeks every health center was screened to identify at least 15 diabetic patients, who attended a medical visit in the previous seven days. At centers where the number of diabetic patients identified were smaller than 15, the screening was extended by a further 15 days, after which it was interrupted at the number already found.

Each subject received a home visit during the week following consultation. To be included in the study, the patient was required to be aware of his/her diabetic condition, to live within the city's urban area, and not to be hospitalized at the time of the interview. A pre-tested structured questionnaire was applied by trained interviewers in order to identify the following characteristics: demographics (gender, race, marital status, and age); socio-economic data (years of schooling and income); disease history (time span since diagnosis, family history, and hospitalization during the preceding year); self-reported co-morbidities (heart or kidney disease, retinopathy, and systemic arterial hypertension); self-reported compliance with the treatment prescribed (diet, physical activity, and medication), smoking history, and number of visits in the preceding six months.

At the end of the interview patients were weighed and their height was measured by study personnel using a portable scale and anthropometer. The body mass index (BMI) was calculated as weight (kg) divided by height squared (m^2). Blood pressure was measured in seated position, once on each arm, and measurements were corrected for arm perimeter,[15] and the average of both arms was registered. Aneroid sphygmomanometers, calibrated monthly, were employed. Capillary glycemia was measured at households with a *Glucotrend* brand (Boehringer Mannheim). The values set for determining poor glycemic control (dependent variable) were based upon levels defined by the American Diabetes Association (ADA)[1] and the Latin American Diabetes Association (ALAD).* Results over 10 mmol/L (180 mg/dL) were considered hyperglycemia.

*Guias ALAD 2000. [For diagnosis and management of type-2 diabetes mellitus with evidence-based medicine]. Available at http://www.alad.org/guiasalad.html [9 Ago 2004]

Health center infrastructure and medical care were also assessed and have been published previously.[3] Briefly, information on medication and supplies availability (oral hypoglycemic agents, insulin, and blood glucose strips); adoption of a specific diabetes management program; use of special registration forms for diabetic patients; health center opening hours; appointment scheduling; and distribution of educational material directed to self-care of diabetic patients, were gathered by interviewing health facilities' managers. All medical doctors attending diabetic patients in every health center were interviewed concerning their medical specialty, current number of jobs, duration of tenure at the health center, and self-reported satisfaction with care delivered. Based upon recommendations from the American Diabetes Association,[1] the quality of the care provided was assessed by asking medical doctors about physical examination and case management at their first contact with patients already known to have diabetes. Right answers should include, at least, measure of the patient's weight, prescription of diet and physical activity, and request of glycated hemoglobin test. Also, medical records were analyzed for at least one record of weight, blood pressure, and glycemia during the preceding year.

To check reliability of the data collected, 10% of the interviews with health center managers, physicians, and patients, randomly selected, were repeated by the fieldwork supervisor. The Kappa test results were always higher than 0.85. This study has been approved by the Ethics Committee of the *Faculdade de Medicina da Universidade Federal de Pelotas* and *Secretaria Municipal de Saúde*. Data analyses were conducted by logistic regression (multilevel method).[10] A multivariate model, aiming at taking into account the interdependence between patients attending the same PHC center, was used. The highest hierarchical level was the PHC center, the second level was the physicians, and the third level was the patients. Analyses were carried out according to a conceptual model for determining poor glycemic control.

Considering the differences in diabetic patient enrollment time among the various health facilities, as well as the possibility that patients seen at centers with lower demand could hence be managed less efficiently and, consequently, have worse disease control, data were weighted according to the number of patients per health center. After weighting, however, the proportion of patients with poor glycemic control did not change more than 1%, and thus this procedure was not taken into account in subsequent analyses.

RESULTS

A total of 461 diabetic patients were identified. Of these, 65 were excluded: three died before the interview; five were hospitalized; 13 lived in other cities; and 44 were not aware of having diabetes. Of 396 eligible patients, eight refused to be interviewed and ten were not found at home after three visits on different days and at different times, which resulted in 4.5% loss. Of 378 diabetic patients interviewed, 372 were included in the study – four were under 20 years old while inclusion criteria were for adult patients[1] and two refused capillary blood sampling. The number of patients screened per facility ranged from two to 23. Table 1 describes the distribution of glycemic levels in relation to fasting period. A 50.5% prevalence of poor glycemic control was found. The minimal postprandial period before blood collection was 1.5 hour. Most measurements (77%) were performed after periods of fasting ranging between two and eight hours. The frequency of glycemic control increased linearly with the duration of the fasting period (p=0.02).

The majority of the subjects presenting hyperglycemia was over 50 years old, had a family income of fewer than three minimum wages, and up to eight years of schooling. About 15% of them had a history of at least one hospitalization due to diabetes since treatment was initiated in the health center at which they were identified. Among subjects who were diagnosed as having diabetes over five years prior to the interview, hypertension was the most prevalent self-reported co-morbidity. One third of the subjects presented normal blood pressure, and about 43.1% had BMI below 27 kg/m^2. As to treatment regimen, 84% said to be using an oral hypoglycemic agent. Of the 143 hyperg-

Table 1 - Distribution of glycemic levels according to time since last meal. Pelotas, Brazil, 1998.

Fasting time (hours)	N	Glycemia ≤10 mmol/L N (%)	>10 mmol/L* N (%)	Mean ± standard deviation (mmol/L)**
1:30	27	11 (40.7)	16 (59.3)	13.08±6.91
1:31-2:00	34	14 (41.2)	20 (58.8)	13.23±6.34
2:01-5:00	261	126 (48.3)	135 (51.7)	11.92±6.36
5:01-8:00	27	14 (51.9)	13 (48.1)	12.46±7.74
>8:00	23	19 (82.6)	4 (17.4)	8.23±4.15
Total	372	184 (49.5)	188 (50.5)	11.94±6.46

*Chi-square for trend, p=0.02
**ANOVA, p=0.04

lycemic patients who reported having received dietary advice, 49% said to have followed it in the last 15 days. The majority of patients (83%) had two or more visits in the previous six months (Table 2).

Characteristics of facility infrastructure as well as aspects of medical care of all patients included in the study and those presenting hyperglycemia are described in Table 3. Of all the patients seen at the health centers, 10% followed some kind of diabetes care program. Diabetic patients were assisted by 58 physicians and 52% hyperglycemic patients were managed by non-specialists, or by professionals specialized in internal medicine or general practice. About 80% of the patients were seen by physicians who worked at the health centers for over one year. The majority was seen by female physicians (65%), who had three or more different jobs (63%), and who reported themselves as being satisfied with the available conditions at the health facility for diabetic patient management. Table 3 shows that among patients using oral hypoglycemic agents - OHA (n=246) or insulin (n=40), 63.0% and 57.5% attended visits where those medications were regularly available.

Of all subjects, 24 (6.5%) were seen by medical doctors who reported that at their first contact with an already known diabetic patient they would weigh the patient, prescribe a diet and physical activity, and request glycated hemoglobin for glycemic control evaluation purposes (there were no restrictions for this test in the PHCN). Considering 323 patients whose records could be analyzed, for 166 (51%) of them there was at least one record containing weight, blood pressure, and glycemia levels.

Crude analysis showed that lower BMI, longer span since diagnosis, insulin or oral hypoglycemic agent treatment, and physician having many jobs were variables statistically associated to poor glycemic control. The multivariate analysis is described in Table 4. Variables which remained associated to hyperglyc-

Table 2 - Distribution and frequency of glycemia according to demographic and socio-economic characteristics, self-reported co-morbidities, disease history, and clinical management of patients.

Patient characteristics	Total (N=372)	Glycemia >10 mmol/L (N=188)
Female	70.4	72.3
White skin color	75.8	76.1
Living with a partner	64.5	68.1
Age (years)	58.7±12.7	57.8±12.5
Age group (years)		
≤50	25.3	28.2
51 to 60	29.3	28.7
61 to 70	27.2	26.6
≥71	18.2	16.5
Family monthly income (in minimum wages)		
≤1	20.7	18.1
1.1-2.9	49.2	50.0
3.0-5.9	23.9	25.0
≥6	6.2	6.9
Schooling (years)		
0	34.9	34.0
1-4	34.8	35.6
5-8	24.7	23.9
≥9	5.6	6.4
Diabetes for 5 years or longer	52.6	60.1
Diabetic family member	62.3	64.4
Hospitalization since started treatment at the primary health center	14.0	14.9
Self-reported co-morbidities*		
Cardiovascular disease	37.5	35.4
Renal disease	15.8	11.5
Retinopathy	35.2	38.1
Arterial hypertension	67.3	67.3
Blood pressure ≤140x90**	37.8	34.4
BMI <27 kg/m²**	35.6	43.1
Current use of diabetes medication	75.5	84.0
Insulin	10.8	12.8
Oral hypoglycemic agent	66.5	73.3
Only diet***	14.5	9.1
Complied with diet in the last 15 days	53.2	49.0
Physical exercise during last month	25.0	23.4
Current smoker	18.0	17.0
Medical visits in the last six months****		
1	18.1	17.3
2	29.5	27.6
3 or more	52.4	55.1

Data: mean ± standard deviation or %
BMI: Body mass index
*Only subjects diagnosed as diabetic over 5 years prior to the interviews (N=196/113)
**N=370/186
***Only subjects who received dietary advice (N=282/183)
****N=366/185

Table 3 - Distribution and frequency of glycemia of patients according to service infrastructure and physician characteristics of the primary health care system.

Characteristics	Total (N=372)	Glycemia >10 mmo/L (N=188)
Service infrastructure		
Diabetes patient care program	9.9	9.6
Working shifts per day		
1	40.3	35.6
2	42.2	46.3
3	17.5	18.1
Educational material available	35.5	33.5
Scheduling of medical visits	48.7	50.0
Special records for diabetic patients	21.0	20.2
Capillary glycemia measuring bands available	16.1	15.4
OHA* available	63.0	63.5
Insulin** available	57.5	4.2
Physician characteristics* **		
Specialization in:		
Internal medicine or general practice	43.1	44.8
Endocrinology	3.8	3.3
None or unrelated area	53.1	51.9
Female doctor	65.1	68.9
Current number of jobs		
1-2	37.1	31.7
≥3	62.9	68.3
Duration of tenure at the health center (years)		
<1	23.7	19.7
1-4	30.0	32.2
5-8	26.7	26.2
≥9	19.6	21.9

Data: mean ± standard deviation or %
*Only for oral Hypoglycemic Agent users (N=246/137)
**Only for insulin users (N=40/24)
***N=367/183

emia after controlling for family income, age, and fasting time were BMI, use of pharmacological treatment, and time span since diagnosis. Patients with BMI below 27 kg/m^2 had a 1.72 odds ratio (OR) (95% CI 1.09-2.70) for poor glycemic control compared to those with BMI equal or above 27 kg/m^2. The odds ratio for hyperglycemia in patients aware of their disease for over five years was about 70% higher than that of diabetic patients with more recent diagnoses (OR=1.69; 95% CI 1.09-2.63). Insulin or oral hypoglycemic agent use was also associated to poor glycemic control (OR=2.56; 95% CI 1.49-4.34).

DISCUSSION

This study has simultaneously evaluated patient demographic and socio-economic characteristics, treatment regimens, health facility infrastructure data and medical care delivered in a community-based representative sample of primary care patients. Considering the reported 4% diabetes mellitus prevalence among adults in urban Brazil[14] and the 30%, Pelotas PHCN utilization,[6] the studied sample probably included about 20% of all adult diabetic patients seen by PHC physicians in the city.

The analysis performed through the multilevel method is a positive aspect of this study. Contextual or multilevel analysis challenge researchers to develop conceptual models which are able to extend through various levels and explain how group and subject-level variables interact.[7] When the units in each level share a similar environment, or have similar characteristics, such as patients seen by the same physician or physi-

Table 4 - Crude and adjusted odds ratio (OR) for glycemia according to patient BMI, time span since diagnosis and use of insulin or hypoglycemic agents.

Variable	Crude OR (95% CI)	p-value	Adjusted OR* (95% CI)	p-value
BMI**<27 kg/m^2		0.01		0.02
No	1.00		1.00	
Yes	1.89 (1.20-2.86)		1.72 (1.09-2.70)	
Time with diabetes		0.005		0.02
Less than 5 years	1.00		1.00	
5 years or more	1.85 (1.22-2.78)		1.69 (1.09-2.63)	
Use of insulin and/or OHA***		<0.001		<0.001
No	1.00		1.00	
Yes	2.70 (1.59-4.35)		2.56 (1.49-4.34)	

BMI: Body mass index
*Adjusted for family income, age and fasting time
**N=370
***OHA: Oral hypoglycemic agent

cians of the same health facility, this assumed independence is violated, and a correlation emerges among the units of a same group.[7,10] Such correlation can render the use of traditional regression models infeasible for they are based upon the assumption that subjects being studied are independent from one another as well as from the outcome.

Apart from design constraints in terms of causality determination, this study has other methodological limitations that should be considered when interpreting its findings. Other patient characteristics, as self-care abilities and psychosocial adjustment for dealing with the disease, for example, were not measured. The main limitation, however, was how the assessment of medical care was investigated. It was based upon physicians self-reports, which could not always be compared to visit records (13% of patient files could not be located). In addition, the medical records generally contained only very brief descriptions, if any, being practically limited to the recording of blood pressure and test results. Consultation observations were not included in this study; these observations, although likely to overestimate the performance of certain procedures and managements, are indicated when recording is poor.[8]

An interesting finding was that half of the patients seen by internists or general practitioners had good glycemic control, pointing out to the adequacy of non-specialist medical doctors for managing diabetic patients at the PHC level (Table 3).

The use of capillary glycemia is another limitation of this study. Patient care should be evaluated through diabetes control, and that this control should be confirmed through glycated hemoglobin measurement, preferably A_{1c} glycated hemoglobin (HbA_{1c}). In a local study,[2] however, 30% of patients did not show up for glycated hemoglobin measurements, and a similar proportion would likewise be expected in this study due to the similarities between the populations studied. Such high loss would impair risk factor analysis.

Recent studies, however, have showed that postprandial hyperglycemia is an independent risk factor for heart disease in type-2 diabetes patients. This suggests that treatment efficacy evaluations cannot be restricted to fasting plasma glucose and/or HbA_{1c} evaluation,[12,17,20] which would justify measurements at other times of the day. Thus, the finding of 50% hyperglycemic subjects in postprandial state or after more hours of fasting a short time after consultation – when all therapeutic recommendations should have been reviewed and/or reinforced – is worrisome for it indicates that these patients are likely to remain in this state most of the time, which certainly has an effect upon the evaluation of disease control and the occurrence of complications.

In this study, no association (multilevel method) was found between poor glycemic control and health facility infrastructure or physician characteristics. It showed to be associated, instead, to the patient characteristics (time span since diagnosis, BMI and use of pharmacological treatment).

Due to the high prevalence of the outcome studied, however, risk estimates expressed as odds ratios were surely overestimating the actual relative risk.[18] The crude odds ratios shown in Table 4, however, did not change the direction of the effects seen in the prevalence ratios.

The observed association between hyperglycemia and time span since diagnosis is consistent with the literature[5,9] suggesting that among diabetic patients a decreased sensitivity to insulin or a progressive failure of pancreatic β-cells function develops over time.

Also in agreement with the literature is the observed association between poor glycemic control and the use of oral hypoglycemic agents,[5,9] which remained significant even after controlling for time span since diagnosis. Corroborating to it is the fact that, in the studied sample, 41% of the patients in use of an oral hypoglycemic agent were taking dosages below or above those considered clinically effective.[4] A subanalysis of the patients receiving adequate dose, as an independent variable, however, showed no significant association with the glycemic control. Another aspect to be considered is that drug prescription for type-2 diabetic patients is recommended only when dietary and lifestyle changes fail to control the disease.[19] Thus, drug prescription is compatible with manifestations of more severe forms of the disease, which go together with a greater occurrence of poor glycemic control.

In the studied sample, BMIs below 27 kg/m^2 were associated to a greater likelihood of hyperglycemia. This finding is consistent with the fact that in the non-obese diabetic, mild to severe hyperglycemia is usually due to refractoriness of β-cells to glucose stimulation. The resulting insulinopenia leads to weight loss, a clinical manifestation of uncontrolled diabetes. Also, since this study did not collect data on reasons for consultation, the effect of infectious diseases over the higher prevalence of hyperglycemia observed among patients with BMI below 27 kg/m^2 could not be ruled out. In addition, it is an international consensus that roughly 25% of type-2 diabetic patients are expected

to require the use of insulin for glycemic control,[16] and that this type of treatment is more likely to be used by slimmer patients.[19] In Brazil this proportion is about 8%, possibly indicating a lack of training among medical doctors on insulin prescription to type-2 diabetic patients.[16] Reluctance of the latter's in using this kind of medication can not also be ruled out. The high prevalence of diabetes-related co-morbidities reported by subjects diagnosed as diabetic over five years prior to the interview is equally important. Even considering that the study design does not allow analyses of temporality, this finding suggests that these co-morbidities can be due to poorly-controlled diabetes. The frequency of these conditions, however, was obtained through self-reporting, which is a limitation in this study. For this reason, such characteristics were taken into consideration for descriptive purposes only, not being employed in the multivariate analysis.

In conclusion, inferences about the adequacy of the impact of diabetic patients care at PHCN in Pelotas can be properly drawn from this study.[10] The results showed that only half of the patients met the set criteria for adequate glycemic control. Only variables at the patient level showed to be statistically associated with the outcome. Among those, the use of drug therapy for diabetes management was most strongly associated with poor glycemic control. Drug prescription, however, is a medical action and part of the disease control depends upon its appropriateness. As is the case in many PHC settings in developing countries, at the time of this study there was no diabetic patient care program running at local level. From the study results it seems that such a program is needed. The totality of the health facilities should be appropriately equipped for diabetes care and protocols for case management should be instituted as a mean of care process orientation. Meanwhile, in the short term, special attention must be given to patients diagnosed as diabetic a long while ago, as well as to the adequacy of drug prescription and to weight monitoring of diabetic patients.

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REFERENCES

1. American Diabetes Association. Standards of medical care in diabetes. *Diabetes Care* 2004;27 Suppl 1:S15-S35.

2. Araújo RB, Santos I, Cavaleti MA, Costa JSD, Béria JU. Assessment of diabetic patient management at primary health care level. *Rev Saúde Pública* 1999;33:24-32.

3. Assunção MC, Santos IS, Gigante DP. Atenção primária em diabetes no sul do país: estrutura, processo e resultado. *Rev Saúde Pública* 2001;35:88-95.

4. Assunção MC, Santos IS, Costa JSD. Clinical management of diabetic patients: process evaluation in Pelotas, Southern Brazil. *Cad Saúde Pública* 2002;18:205-11.

5. Blaum CS, Velez L, Hiss RG, Halter JB. Characteristics related to poor glycemic control in NIDDM patients in community practice. *Diabetes Care* 1997;20:7-11.

6. Costa JSD, Fachini LA. Use of outpatient services in an urban area of Southern Brazil: place and frequency. *Rev Saúde Pública* 1997;31:360-9.

7. Diez-Roux AV. Bringing context back into epidemiology: variables and fallacies in multilevel analysis. *Am J Public Health* 1998;88:216-22.

8. Donabedian A. The quality of care. How can it be assessed? *JAMA* 1988;260(12):1743-8.

9. Ferrannini E, Stern MP, Galvan AQ, Mitchell BD, Hafner SM. Impact of associated conditions on glycemic control of NIDDM patients. *Diabetes Care* 1992;15:508-14.

10. Goldstein H. Multilevel statistical models. 2nd ed. London: Kendall's Library of Statistics; 1995.

11. Habicht JP, Victora CG, Vaughan JP. Evaluation designs for adequacy, plausibility and probability of public health programme performance and impact. *Int J Epidemiol* 1999;8:10-8.

12. Hanefeld M, Koehler C, Schaper F, Fuecker K, Henkel E, Temelkova-Kurktschiev T. Postprandial plasma glucose is an independent risk factor for increased carotid intima-media thickness in non-diabetic individuals. *Atherosclerosis* 1999;144:229-35.

13. Kerr CP. Improving outcomes in diabetes: a review of the outpatient care of NIDDM patients. *J Fam Pract* 1995;40:63-75.

14. Malerbi DA, Franco LJ. The Brazilian Cooperative Group on the Study of Diabetes Prevalence. Multicenter study of the prevalence of diabetes mellitus and impaired glucose tolerance in the urban Brazilian population aged 30-69 years. *Diabetes Care* 1992;15:1509-16.

15. Maxwell MH, Schroth PC, Dornfield LP, Waks AU, Karam M. Error in blood-pressure measurement due to incorrect cuff size in obese patients. *Lancet* 1982;2:33-6.

16. Ministério da Saúde. Diabetes mellitus: guia básico para diagnóstico e tratamento. Brasília (DF); 1997.

17. Parkin CG, Brooks N. Is postprandial glucose control important? Is it practical in primary care settings? *Clin Diabetes* 2002;20:71-6.

18. Rothman KJ, Greenland S. Modern epidemiology. 2nd ed. Philadelphia: Lippincott-Raven; 1998.

19. Schmidt MI. Diabetes mellitus. In: Duncan BB, Schmidt MI, Giugliani E et al. Medicina ambulatorial: condutas clínicas em atenção primária. Porto Alegre: Artes Médicas; 1996. p. 476-89.

20. Temelkova-Kurktschiev TS, Koehler C, Henkel D, Leonhardt W, Fuecker K, Hanefeld M. Postchallenge plasma glucose and glycemic spikes are more strongly associated with atherosclerosis than fasting glucose or HbA1c level. *Diabetes Care* 2000;23:1830-4.