Diabetes mellitus and impaired glucose tolerance in urban adult population

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Summary

Objective: Estimating the prevalence of diabetes mellitus (DM) and impaired glucose tolerance (IGT) in the urban population aged between 30 and 69 years in the municipality of Campo Grande, state of Mato Grosso do Sul, Brazil.
Methods: Population-based cross-sectional study conducted between October/2009 and February/2011. The investigation included the determination of fasting glucose and participants with blood glucose ≥ 200 mg/dL were considered diabetic. Nondiabetic patients, which showed blood glucose ≥ 100 mg/dL and < 200 mg/dL, underwent an oral glucose tolerance test (OGTT) to investigate whether they had DM or IGT.
Results: 1.429 individuals participated in this investigation. The general prevalence, adjusted for sex and age, were: 12.3% for DM (95%CI: 10.5 to 13.9%) and 7.1% for IGT (95%CI: 5.7 to 8.4%). There was a higher prevalence of DM with increasing age in people with low educational level, family history of diabetes, overweight, obesity and central obesity. Among diabetic patients (n = 195), 25% were unaware they had the disease and were diagnosed through investigation. Among patients who already knew they had DM (n = 146), 37% were unaware of the potential chronic complications.
Conclusion: This study confirms the increased prevalence of DM in Brazil and emphasizes the need for early diagnosis, as well as the importance of strict adherence to medical treatment in order to prevent its much feared complications.

Key words: diabetes mellitus, disorders of glucose metabolism, chronic disease, prevalence, lifestyle, medical care.

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Introduction

Diabetes mellitus (DM) is a complex and multifactorial metabolic disorder primarily characterized by a state of chronic hyperglycemia. There are several conditions that can lead to this disease, such as autoimmune destruction of beta cells in the islets of Langerhans of the pancreas, known as type 1 DM. Nevertheless, in about 90% of cases, the cause stems from the association between obesity, insulin resistance and beta cell failure, which is called type 2 DM. Several other conditions may also lead to diabetes, such as pregnancy, some tumors and pancreatic diseases.[1]

There is a group in the population with blood glucose levels higher than normal, but still does not meet the laboratory diagnostic criteria of DM. This intermediate range includes individuals with impaired fasting glucose (IFG) and those with impaired glucose tolerance (IGT), confirmed by oral glucose tolerance test (OGTT).[2] About 25% of the members of this group will develop diabetes in 3 to 5 years. Furthermore, there is evidence that these individuals may progress already showing the same tissue damage resulting from DM.[3,4]

The World Health Organization (WHO) estimates, considering all age groups, a prevalence of 2.8% of diabetics worldwide in 2000, which corresponded to 171 million people, and predicted for 2030 an increase to 4.4%, which would affect approximately 366 million people. Countries like the United States and China should double the number of diabetics in this period.[5]

The growth of DM should be even more intense in developing countries, specifically in the Middle East, in the sub-Saharan Africa and in India. Brazil is among the 10 countries in which the largest expansion of the disease is expected by 2030.[5] The Brazilian Diabetes Society (SBD) believes that in 2012, there were close to 12 million diabetics in Brazil.[6]

When considering the progress of diabetes, its profound socioeconomic impact and its great potential to create serious complications in the body, extensive knowledge of epidemiological data of this disease is crucial, because only then it will be possible to develop and implement effective health actions for prevention, appropriate treatment and reduction of the huge negative financial impact of DM in terms of public spending.[7,8]

In this context, this research focused on estimating the prevalence of DM and IGT in the urban adult population of the municipality of Campo Grande, MS, by socioeconomic status, family history of DM and presence of overweight, obesity and central obesity. Another objective was to evaluate the profile of the study participants who already had a diagnosis of diabetes with respect to treatment adherence and knowledge of chronic complications that can arise from this disease, and also of those who had a diagnosis of DM through this study.

Methods

This cross-sectional population-based study was carried out from 10/2009 to 2/2011 by means of home visits in adults 30-69 years of age residing in the urban area of Campo Grande, capital of Mato Grosso do Sul (MS), in the Midwest region of Brazil. The city is located in the center of the state, in the hills of Maracaju, and is divided into seven urban districts (Centre, Segredo, Prosa, Bandeira, Anhanduizinho, Lagoa and Imbirussu). The population, according to the 2010 census,[9] was 786.797 people, comprising 51.5% women and 48.5% men, so that 98.7% of the population lived in urban areas.

The minimum size calculated for the sample[10] was 1.068 participants. Confidence interval of 95% and a prevalence of 50% (± 3%) were considered. A 30% increase was designed to cover possible losses and refusals.

Of each administrative region, around 15% of census tracts were drawn, which resulted in the selection of 103 of the 682 listed by the Brazilian Census Bureau, IBGE. The quantity of sectors was defined by operational issues, because the greater the number of sectors, the higher the demand for movement, considering a minimum of two visits per household.

In this research, a random sample was used, with two main strata for male and female genders. These broader strata included sub-strata formed by the age group of 30 to 69 years, which were divided into 5-year age intervals. Each sector had a randomly selected representative sample of individuals studied, corresponding to its population distribution and the formation of the corresponding strata and sub-strata.

After determining the residences to be investigated, visits were made in two stages. On the first visit, a clarification on the content and importance of the study was done. If the resident fulfilled the inclusion criteria, that is, being in the age group 30-69 years and accepting to take part in the study, a consent form for their participation was then signed. Pregnant women were excluded from the study, since in that case the glycemic diagnostic values are different and diabetes may be just circumstantial, disappearing after delivery.

Still on the first visit, an interview was conducted with a standardized form containing questions regarding identification (gender, age and race), socioeconomic data (monthly income and education), previous diagnosis of DM, and whether there are any diabetics in the family. Subsequently, a second visit was made, usually the day after the first contact, in which a brief physical examination and blood glucose test measures to investigate DM or IGT were performed.

The interview, physical examination and measurement of blood glucose were made at the homes of participants and run by doctors and medicine students at Anhanguera University-Uniderp, who received training and were continuously supervised by a study coordinator.

Physical examination included weight, height, body mass index (BMI) and waist circumference (WC). Individuals with a BMI between 25 and 29.9 kg/m² were considered overweight and those over 30 kg/m² were considered obese. Male participants with WC greater than 102 cm and females over 88 cm were considered with central obesity.

Body weight was measured using portable digital scales from Tanita® brand, with a variation of 0.1 kg and capacity of up to 150 kg, precisely calibrated before and du-

ring the study. Waist circumference and height were measured using, respectively, tape measure and metallic tape by Lufkin®, with 0.1 cm variation to reach 3 meters.

The measurement of fasting capillary glucose (FCG) was performed in all participants except those with a previous diagnosis of DM confirmed by laboratory tests and prescription of insulin or oral hypoglycemic agent. The individuals were instructed at the first visit to fast for 10 to 12 hours for measurement of blood glucose in the morning. Lancets and disposable test strips were used for the procedure, and the Accu-Chek Performa glucose meter (Roche®) for measurement of glucose, which has immediate readings (5 seconds) and dosage range of blood glucose 10 to 600 mg/dL. These monitors were calibrated and tested before the study and then every 15 days during its usage.

Those who had fasting glucose <100 mg/dL in the investigation were normal and blood glucose ≥ 200 mg/dL, diabetic. Individuals with a fasting blood glucose levels ≥ 100 and < 200 mg/dL, in turn, like 1/6 of those with normal glucose were subjected to an OGTT.[11] In this test, the blood glucose was measured at 2 hours after ingestion of 75 g anhydrous glucose dissolved in a glass of water. Individuals who had blood glucose <140 mg/dL were considered normal, those with glucose ≥ 140 and < 200 mg/dL, with IGT and those with a blood glucose ≥ 200 mg/dL were diagnosed as diabetic.

To calculate the adjusted overall prevalence of DM and IGT, the population census of 2010 was used as a standard.[9] The standard population, we obtained the weights expressed by the proportions of individuals in each age group and gender, which were applied to the prevalence of diabetic individuals.

To compare proportions, we used Chi-square (χ^2) test. Prevalence ratios were calculated with respective confidence intervals of 95%. The level of significance was $p < 0.05$. Statistical programs used were: Minitab 14 for Windows® (Minitab Inc., State College, Pennsylvania, USA) and Bio Estat 5.3 (Sociedade Mamirauá, Belém, Pará, Brazil).

This study was approved by the Ethics and Research Committee of Anhanguera University - Uniderp (n. 119/07). All ethical precepts contained in Resolution number 196/96 of the National Health Council were followed.

Results

In this study, 1.429 individuals were included, 827 (58%) women and 602 (42%) men. The mean age of participants was 47.6 years. There was 6% of loss or refusal, which is thus less than expected (30%) in the sample calculation.

The following general prevalence for the population 30-69 years of age in the municipality of Campo Grande/MS were estimated: for DM, the unadjusted prevalence was 13.7%, and the adjusted prevalence by sex and age group, 12.3% (95% CI: 10.5 to 13.9%); for IGT, unadjusted prevalence was 7.3% and adjusted prevalence was 7.1% (95% CI: 5.7 to 8.4%). The unadjusted prevalence by sex and age group, and overall adjusted prevalence of DM and IGT are described in table 1.

TABLE 1 Unadjusted and adjusted prevalences of diabetes mellitus (DM) and impaired glucose tolerance (IGT), by sex and age group, in the population of Campo Grande, MS

Variables	Women (n=827)			Men (n=602)			All (n=1.429)		
	n	%	Total	n	%	Total	n	%	Total
DM									
30 to 39 years	9	3.8	237	11	5.2	213	20	4.4	450
40 to 49 years	27	11.0	245	17	10.1	168	44	10.7	413
50 to 59 years	36	19.0	189	20	17.4	115	56	18.4	304
60 to 69 years	40	25.6	156	35	33.0	106	75	28.6	262
Unadjusted prevalence	13.5%			13.8%			13.7%		
Adjusted prevalence	12.1%			12.6%			12.3%		
IGT									
30 to 39 years	10	4.2	237	10	4.7	213	20	4.4	450
40 to 49 years	14	5.7	245	11	6.5	168	25	6.1	413
50 to 59 years	22	11.6	189	13	11.3	115	35	11.5	304
60 to 69 years	7	4.5	156	17	16.0	106	24	9.2	262
Unadjusted prevalence	6.4%			8.5%			7.3%		
Adjusted prevalence	6.3%			8.0%			7.1%		

Regarding gender, there was no statistically significant difference (p = 0.894) in the prevalence of DM among men (13.8%) and women (13.5%) (Table 2). However, there was a progressive and significant increase in the prevalence of DM with increasing age, regardless of sex, from 4.4% for people between 30 and 39 years of age to 28.6% in the range of 60 to 69 years, i.e., a 6.5-fold increase (tables 1 and 2).

This study verified that those individuals with less education have significantly higher frequency of DM compared to those with higher educational achievement (p < 0.001). Nevertheless, no significant difference was observed when the presence of DM was correlated with the monthly income of the participants (p = 0.161) and ethnicity (p = 0.443) (table 2).

It was found that, among participants who had first--degree relatives with diabetes, there was a significantly higher prevalence of DM compared to those without kinship (p < 0.001). The research also showed a statistically significant difference in the correlation between DM and overweight, obesity and central obesity (p < 0.001) (table 2).

Of the total number of diabetics (n = 195), 25% were unaware they had the disease, being diagnosed during the study (26% for fasting glucose and 74% by OGTT). Considering the following four factors: age greater than 50 years, DM family history, excess body weight or central obesity, the prevalence of DM significantly increased as the number of these risk factors also increased (table 2).

TABLE 2 Number and percentage of individuals, according to socioeconomic variables and the presence or absence of diabetes, Campo Grande, MS (n = 1.429)

Variables	Diabetes				PR [1] (95% IC)	P
	Yes (n= 195)		No (n= 1234)			
	n	%	n	%		
Gender						
Female	112	13.5	715	86.5	1	[2] 0.894
Male	83	13.8	519	86.2	0.98 (0.75 to 1.28)	
Age						
60 to 69 years	75	28.6	187	71.4	1	
50 to 59 years	56	18.4	248	81.6	1.55(1.15 to 2.11)	[3] < 0.001
40 to 49 years	44	10.7	369	89.3	2.69 (1.92 to 3.77)	
30 to 39 years	20	4.4	430	95.6	6.44 (4.03 to 10.30)	
Monthly income						
No data	1	50.0	1	50.0	-	
Up to 2 minimum wages	92	15.9	487	84.1	1	[3] 0.161
From 2.1 to 5 minimum wages	59	11.2	467	88.8	1.42 (1.04 to 1.92)	
More than 5 minimum wages	43	13.4	279	86.6	1.19 (0.85 to 1.66)	
Education						
Incomplete primary education	102	18.3	456	81.7	1	
Primary education	27	10.3	234	89.7	1.77 (1.19– 2.63)	[3] < 0.001
High school	49	12.4	345	87.6	1.47 (1.07– 2.01)	
Undergraduate	17	7.9	199	92.1	2.32 (1.42– 3.79)	
Race						
No data	-	-	1	100.0	-	
White	115	14.3	691	85.7	1	[2] 0.443
Non white	80	12.9	542	87.1	1.11 (0.85 to 1.45)	
Body weight						
Obesity	92	21.6	333	78.4	1	[3] < 0.001
Overweight	67	12.5	468	87.5	1.73 (1.30 to 2.31)	
Normal	36	7.7	433	92.3	2.82 (1.96 to 4.05)	
Central obesity						
Yes	145	19.1	613	80.9	1	[2] < 0.001
No	50	7.5	621	92.5	2.57 (1.89 to 3.48)	
Diabetic person in the family						
No data	12	12.2	78	87.8	-	
Yes	127	19.9	511	80.1	1	[2] < 0.001
No	56	8.0	645	92.0	2.49 (1.85 to 3.35)	
Risk factors [4]						
Four	57	40.1	85	59.9	1	[3] < 0.001
Three	84	20.4	327	79.6	1.96 (1.49 to 2.59)	
Two	32	8.0	370	92.0	5.04 (3.42 to 7.44)	
One	18	5.7	299	94.3	7.07 (4.32 to 11.56)	
None	4	2.5	153	97.5	15.76 (5.87 to 42.32)	

Note: if p ≤ 0.05, statistically significant difference. Whenever present, the "no data" category was deleted from test calculations.
[1] PR = Prevalence ratio
[2] Chi-square test
[3] Chi-square test for trend.
[4] Risk factors taken into account: age over 50 years, family history of DM, excess body weight or central obesity.

Among participants who already had a diagnosis of DM (n = 146), 6.2% were not monitored by a physician; among those who were undergoing treatment (n = 137), 7.3% waited more than 1 year between each medical visit (table 3).

When the group aware of having diabetes was questioned about knowledge of the possible complications of chronic disease, 37% responded that they were unaware of any possible outcomes. Of the 63% who made references to the possible consequences of diabetes, the most cited were: blindness, lower limb amputation and kidney failure (table 3).

TABLE 3 Number and percentage of diabetic individuals, according to medical supervision and chronic complications, Campo Grande, MS (2009 to 2011)

Variables	Partial result	n	%
Medical supervision	146		
No		9	6.2
Yes		137	93.8
Medical consultation	137		
< 3 months		58	42.3
3 to 6 months		58	42.3
> 6 months to 1 year		11	8.1
> 1 year		10	7.3
Chronic complications*	146		
Don't know		54	37.0
Blindness		92	63.0
Lower limb amputation		53	36.3
Kidney failure		48	32.9
Heart attack		29	19.9
Stroke		23	15.8
Neuropathy		1	0.7

*Each diabetic could indicate one or more complications.

Discussion

There are few studies concerning the frequency of diabetes in Brazil.[12-21] In addition, marked differences in methods employed and age groups surveyed make it very difficult to compare these investigations. Some studies analyzed populations as from childhood or adolescence, while others evaluated adults only. Disagreements regarding the collection of blood glucose are also considerable. While in some studies only venous blood glucose was measured, in other studies capillary glycemia was assessed and, occasionally, a blood glucose curve was performed.

This study found that the population aged 30-69 years in the urban area of the municipality of Campo Grande has a prevalence of 12.3% for DM and 7.1% for IGT. These rates of diabetes are consistent with more recent studies, such as research conducted in Ribeirão Preto, which found 12.1% of individuals in the age range of 30-69 years,[13] and the work carried out in the city of São Carlos, which found 13.5% in a population from 30 to 79 years.[14] These data, compared with the classic multicenter study conducted in nine Brazilian cities between 1986 and 1988 that found an average prevalence of 7.6%,[12] showed an increase in the prevalence of DM.

This study showed no significant difference in the frequency of DM between men and women. Current similarities of male and female behavior, in which sedentary lifestyles, large caloric intake, obesity and stress prevail, seem to override any genetic, hormonal or constitutional influence and both sexes are equally predisposed to the development of diabetes. However, the growth of disease prevalence with advancing age in all age groups is evident.

With aging, the events that predispose to diabetes are common, as well as little physical activity. Dysfunction of β cells is then seen, with less insulin production, mainly due to a considerable deposition of amyloid β in these cells, and there is still a significant increase in insulin resistance due to changes in body composition (e.g., decrease in lean body mass and increased fat mass), especially in the abdominal region. The findings in this study are consistent with other research,[13,14] showing that diabetes does not favor any sex, but is considerably more prevalent with increasing age.

With regard to skin color, based on the reference of white and nonwhite individuals, the research did not find a significant relationship with diabetes. However, some authors found the opposite and said that blacks have more commonly insulin resistance, hyperinsulinemia and pancreatic failure than whites and therefore have a higher prevalence of DM and IGT.[22,23]

Regarding socioeconomic variables, research has shown that the lower the educational level, the higher the prevalence of DM. This finding suggests that those who have more access to knowledge are more concerned with the prevention of disease.[13,14] On the other hand, this research revealed that the monthly income is not a factor that significantly interferes with the onset of diabetes, which leads to the assumption that a higher purchasing power is not necessarily a protective factor against the development of diabetes.[14]

This study showed that diabetics have more first-degree relatives with diabetes than those without the disease in the family, confirming that genetic inheritance is an important factor in the onset of diabetes.[13]

The predominant presence of DM in participants who are overweight and present central obesity, evidenced by increased waist circumference, demonstrates, in accordance with the opinion already well established in the scientific community, that these findings are risk factors that favor the onset of diabetes.[2]

The intra-abdominal visceral fat, compared to the subcutaneous adipose tissue, secretes large amounts of cytokines, such as resistin, TNF-α and IL-6, which come into certain cells, particularly in skeletal muscle cells, and interfere with insulin signaling, causing resistance to this hormone and predisposing to hyperglycemia and DM.[24]

The study also revealed that 25% of study subjects classified as having diabetes were unaware of having the disease, and this finding was also revealed in the investigation of Ribeirão Preto;[13] but in the multicenter study, the rate observed was 50%, while in São Carlos[14] 15% of the participants ignored the fact that they had DM. The concern of diagnosing diabetes early aims at preventing the development of severe chronic complications that can progress silently in individuals who do not know that they have the disease.[3,4]

These findings reinforce the importance of indicating the screening/examination of diabetes in all persons from the age of 45 years and, before that age, when they have any risk factors for developing the disease, such as first-degree relatives with DM, high blood pressure, obesity, dyslipidemia or history of fasting hyperglycemia.[1] This study found a higher prevalence of DM in individuals with overlapping predisposing factors.

Among participants who already had a previous diagnosis of DM, 6.2% were not monitored by a doctor; 7.3% of those who did, waited over a year for a new consultation. This group of individuals is certainly more susceptible to poor control of diabetes due to the lack or poor adherence to treatment and, therefore, is exposed to its serious complications.

The investigation also showed that, among diabetic participants who knew they had the disease, 37% were unaware of the chronic complications, which may lead to less concern for the proper treatment. The consequences most cited by diabetic respondents were blindness, limb amputation and kidney failure. Cardiovascular outcomes are the leading cause of death, although they did not appear among the most mentioned answers.[25] These findings show that increased population awareness about DM in all aspects, especially in relation to its complications, is crucial.

This study, along with others conducted in recent decades, shows that the prevalence of DM is increasing considerably in Brazil. Preventive measures against the disease should be intensified, because it is only through continuous public health actions, both enlightening and effective, which modify lifestyle in large urban areas, reversing the lack of exercise and overeating, that the attempt to stop the progress of diabetes will be possible.[26-28]

Conclusion

This study estimated a prevalence of 12.3% for DM and 7.1% for IGT in the urban population of the municipality of Campo Grande, MS, Brazil. There was a higher prevalence of DM among people with less education, older age, obesity, increased waist circumference, and also among those who had relatives with the disease.

The data found in the survey show that 25% of the diabetics did not know they had the disease and were diagnosed during the investigation, and that approximately one third of patients who already knew they had diabetes were unaware of the potential chronic outcomes. This study confirms the increased prevalence of DM in Brazil and emphasizes the need for its early conclusion, as well as the importance of strict adherence to medical treatment in order to prevent its much feared complications.

Resumo

Diabete melito e tolerância diminuída à glicose em população adulta urbana

Objetivo: estimar a prevalência de diabete melito (DM) e a tolerância diminuída à glicose (TDG) na população urbana de idade entre 30 e 69 anos do município de Campo Grande/MS.

Métodos: estudo transversal de base populacional realizado entre 10/2009 e 2/2011. Na investigação, foi realizada a dosagem da glicemia capilar em jejum e os participantes com glicemia ≥ 200 mg/dL foram considerados diabéticos. Os não diabéticos, que apresentaram glicemia ≥ 100 mg/dL e < 200 mg/dL, foram submetidos a um teste oral de tolerância à glicose (TOTG) para investigar se tinham DM ou TDG.

Resultados: nesta investigação, participaram 1.429 indivíduos. As prevalências gerais, ajustadas por sexo e faixa etária, foram: para DM de 12,3% (IC95%: 10,5 a 13,9%) e para TDG de 7,1% (IC95%: 5,7 a 8,4%). Houve maior prevalência de DM com o aumento da idade, em pessoas com

baixa escolaridade, histórico de diabete na família, sobrepeso, obesidade e obesidade central. Do total de diabéticos (n= 195), 25% não sabiam que tinham a doença e obtiveram o diagnóstico por meio da investigação. Dos pacientes que já sabiam ter DM (n= 146), 37% desconheciam as potenciais complicações crônicas.

Conclusão: este estudo corrobora o aumento da prevalência de DM no Brasil e enfatiza a necessidade de sua constatação precoce, bem como da importância da adesão rigorosa ao tratamento médico com o intuito de prevenir suas temíveis complicações.

Unitermos: diabete melito, transtornos do metabolismo da glicose, doença crônica, prevalência, estilo de vida, cuidados médicos.

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