Risk factors for type 2 diabetes mellitus among adolescents*

FATORES DE RISCO PARA DIABETES MELLITUS TIPO 2 ENTRE ADOLESCENTES

FACTORES DE RIESGO PARA DIABETES MELLITUS TIPO 2 EN ADOLESCENTES

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ABSTRACT

The objective of this study was to identify risk factors for type 2 diabetes (DM2) in a population of private schools adolescents of Fortaleza - Brazil. A total 794 students aged 12 to 17 years, from 12 schools, were evaluated in the months of May, June, August and September 2007. A form was applied approaching sociodemographics aspects, BMI, blood pressure, capillary glycemia and sedentary lifestyle. Approximately 24% of the participants had high BMI, 65% were sedentary and 51% had family history of DM2. In those with larger income, 73.5% had family history of DM2 (p=0.04). About 39% of the adolescents had at least two risk factors for DM2. Most of the risk factors for DM2 identified in this study are changeable, therefore, susceptible to preventive interventions in the school setting.

KEY WORDS

Diabetes mellitus, type 2.
Risk factors.
Adolescent.
Adolescent health.
Public health nursing.

RESUMO

O estudo teve como objetivo identificar fatores de risco para diabetes tipo 2 (DM 2) em uma população de adolescentes de escolas particulares de Fortaleza, Brasil. Foram avaliados 794 alunos, de 12 a 17 anos, em doze escolas, nos meses de maio, junho, agosto e setembro de 2007. Aplicou-se um formulário abordando aspectos sociodemográficos, IMC, pressão arterial, glicemia capilar e sedentarismo. Aproximadamente 24% dos participantes tinham o IMC elevado, 65% eram sedentários e 51% tinham antecedentes familiares de DM 2. Naqueles com maior renda, 73,5% tinham antecedentes familiares de DM 2 (p=0,04). Por volta de 39% dos adolescentes apresentavam pelo menos dois fatores de risco para DM 2. A maior parte dos fatores de risco para DM 2, identificados neste estudo, são modificáveis, portanto passíveis de intervenções preventivas no contexto escolar.

DESCRITORES

Diabetes mellitus tipo 2.
Fatores de risco.
Adolescente.
Saúde do adolescente.
Enfermagem em saúde pública.

RESUMEN

El estudio tuvo como objetivo identificar factores de riesgo para diabetes tipo 2 en una población de adolescentes de escuelas particulares de Fortaleza, Brasil. Fueron evaluados 794 alumnos de entre 12 y 17 años, pertenecientes a doce escuelas, en los meses de mayo, junio, agosto y setiembre de 2007. Se utilizó un formulario abordando aspectos sociodemográficos, IMC, presión arterial, glucemia y sedentarismo. Aproximadamente 24% de los participantes tenía su IMC elevado, 65% eran sedentarios y 51% contaba con antecedentes familiares de DM 2. Entre aquellos con mayores ingresos, 73,5% tenía antecedencia familiar de DM 2 (p=0,04). Aproximadamente el 39% de los adolescentes presentaba al menos dos factores de riesgo para DM 2. La mayor parte de los factores de riesgo para DM 2 identificados en este estudio son modificables, por lo tanto, pasibles de intervenciones preventivas en el contexto escolar.

DESCRIPTORES

Diabetes mellitus tipo 2.
Factores de riesgo.
Adolescente.
Salud del adolescente.
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INTRODUCTION

Type 2 Diabetes Mellitus (DM2) is currently considered one of the main chronic diseases affecting modern society, reaching populations of countries in all biological and economic-social stages[1]. Some factors have been consistently acknowledged as being associated with DM2 in children and adolescents, among them: DM2 family history, obesity, sedentariness, and hypertension[2]. Age, gender and high capillary glucose level are added to these factors[3].

Until recently DM2 was considered a rare disease among adolescents, however, various authors have reported its increased incidence among adolescents in industrialized countries in recent years with characteristics similar to those of adults. The outbreak of DM2 cases during childhood and adolescence is a consequence of a worldwide obesity epidemic and lack of physical exercise. Currently, more than 200 children and adolescents develop the disease every day[4].

The estimates in the United States, the nation most affected by this epidemiological phenomenon, indicate that recently diagnosed DM2 cases in individuals between 10 and 19 years of age correspond to 33% of all cases of DM2 in this country. Another study stresses that the prevalence of this endocrinopathy in this population is 22.3/1,000 between 10 and 14 years of age group and 50.9/1,000 between 15 and 19 years of age[5].

The incidence and prevalence of DM2 in Brazilian adolescents are not known. A detailed search regarding DM2 during adolescence was carried out aiming to provide this information. This search focused on the databases from the Virtual Health Library: Latin American and Caribbean Health Sciences Literature (LILACS), International Database for Medical Literature (MEDLINE), Adolescent Health (ADOLEC), Nursing Database (BDENF) and Scientific Electronic Library Online (SciELO). The literature on DM2 is broad, though when it addresses adolescents, a predominance of studies addressing isolated and common risk factors for DM2 such as hypertension, overweight, sedentariness and metabolic syndrome, is observed.

The onset of DM2 during the adolescence is related to the exposure of this group to the risk factors previously mentioned. A study published in 2007 involving 720 adolescent students of public schools in Fortaleza, CE Brazil verified that 12.9% of the individuals were overweight, 75.3% were sedentary, 15.3% had high blood pressure and the capillary glucose levels of 8.3% were above values considered normal. In relation to family history of diabetes, 1.7% had diabetic siblings; and the parents of 13.6% and the grandparents of 34.5% had the disease[6].

In this context, in agreement with the current public health perspective focused on primary care in which inter-

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ventions aimed to promote health and prevent diseases are carried out, knowledge of these risk factors support health professionals, among them nurses, in the development of educational health actions in schools concerning lifestyle and health issues that make individuals vulnerable to DM2. Additionally, this study can contribute to the literature on this subject and enable the development of comparative studies addressing different populations of adolescents.

Therefore, this study identifies DM2 risk factors among adolescents of private schools in Fortaleza, CE, Brazil.

METHOD

This cross-sectional study was carried out in 12 private schools. According to information from the Regional Center for Educational Development (CREDE), Fortaleza, CE, one of the main Brazilian cities, is divided into six regions and had, in March 2007, 69,741 students registered in schools, whose ages were of interest for this investigation (12-17 years of age); this total represents the study's population.

A formula used in cross-sectional studies with infinite populations was adopted in this study and totaled 720 students.

The initial methodological proposal was to choose, according to convenience, two schools in each region located in distinct neighborhoods and with different infrastructures and socio-economic conditions to develop a overview of Fortaleza. However, many principals would not authorize the research alleging either that students would be exposed, previous studies granted no return to the school, too much time would be spent taking students from classrooms, especially those preparing for university selection tests.

Hence, the initial proposal was changed and only one school in regions 1 and 5 and another four schools in region 2 participated in the study. A larger number of schools in region 2 was selected because the inclusion of only two schools would not meet the sampling requirement for this region. Hence, the investigation included 794 students and 12 schools, that is, 12% of the adolescents registered in private schools in Fortaleza, CE, Brazil.

Individuals were selected in a simple random draw among those who agreed to participate and presented free and informed forms properly signed by themselves and their parents or legal guardians. Those who presented a confirmed diagnosis of diabetes or any condition that would interfere in any of the study's stages, such as adolescents who were noticeably pregnant, for their weight, blood pressure and capillary glucose were possibly altered by a pregnancy, were excluded

Data collection was carried out from March to June and August to September 2007 through a questionnaire ad-

dressing socio-demographic characteristics and physical activity in addition to measurements of weight, height, blood pressure, capillary blood glucose and computation of Body Mass Index (BMI). The team responsible for collecting data was composed of master's students and undergraduate students participating in the CPNp scholarship program and was rigorously trained for the task.

Information that should be answered by the students' parents or legal guardians such as family history concerning DM2 and family income were provided on a questionnaire taken home by the students themselves. Based on the relevant literature, the DM2 risk factors were: being overweight, sedentariness, DM2 family history in 1st and 2nd degree relatives, high blood pressure and high capillary blood glucose[2-3].

Weight was measured with the individuals wearing light clothes and no shoes using a digital portable scale Plenna with capacity for 150kg and precision of 0.1kg. Height was verified using an inelastic metric tape with scale of 0.5cm. To ensure precise measurement, the individuals were instructed to stand erect and motionless, with hands flat on tights and head adjusted on the Frankfurt plane.

With these measures at hand, the BMI was computed based on the formula W/H2 and the participants were classified according to Cole and colleagues' criteria, cited in several national and international publications in the field[7].

The Optium glucometer and test strips were used to measure capillary blood glucose. A drop of blood was collected from the participants' finger tips (after cleaning) with a disposable needle, which, after use, was packed in sharps box and discarded in hospital waste.

Even though fasting venous glucose is a more reliable test, we intended to identify non-diabetic individuals who had their glucose levels, a DM2 risk factor, outside the standards considered normal. Hence, capillary blood glucose was chosen in the same way as in campaigns carried out by the Brazilian Ministry of Health to identify unknown diabetes and glucose intolerance cases. It is a test approved by the Food and Drug Administration (FDA) in the United States with a level of reliability above 90% when compared to the plasma glucose test[8-9].

The glucose test was randomly performed (it was taken without standardizing the time since the last meal) and the following interpreted result was found: lower than 140mg/dl normal; between 141 and 199mg/dl, dubious; between 200 and 270mg/dl, probable diabetes; and higher or equal to 270mg/dl, highly probable diabetes[10]. Individuals considered physically active were those who exercised at least three times a week during 30 minutes[11].

The same master's student performed the blood pressure measurement with the same equipment. For that, aneroid sphygmomanometers calibrated by the National Institute of Metrology, Standardization and Industrial Quality (INMETRO), and cuffs of different sizes, with the width

of rubber equal to 40% of arm circumference and length involving at least 80% of arm circumference. A binaural stethoscope for the auscultatory technique was used. Measurements were recorded three times at intervals of one minute, and the average of the last two measurements was considered the individual's blood pressure[12].

Before checking blood pressure, the individuals were instructed to: rest in a calm environment for at least five minutes before taking the measurement; sit without crossing the legs with feet supported on the floor and back leaning against the chair; have an emptied bladder; arm at the heart level (the midpoint of the sternum or fourth intercostal space) with palm facing upward and the elbow slightly flexed; keep quiet during the procedure; not use drugs or stimulants (alcohol, coffee or tobacco) 30 minutes before the procedure[12]. The cuff bottom edge was placed 2 to 3 cm above the antecubital fossa, leaving space for placing the diaphragm of the stethoscope on the brachial pulse.

In relation to the classification of blood pressure levels taking into account gender, age and height percentile, the adolescents with systolic and diastolic pressure below values corresponding to the 90th percentile were considered normal. Those with systolic and/or diastolic values above or equal to those corresponding with the 90th percentile were called pre-hypertensive. Adolescents with systolic and diastolic pressure levels above or equal to values corresponding to the 95th percentile were considered to have high level of blood pressure or supposedly be hypertensive[12].

Collected data were entered by three members from the team and after comparison stored in a database. Data analysis was performed using the SPSS version 16.0 through central tendency measures and Chi-square test in the case of association of categorical variables. The level of significance was fixed at 5%.

The study was initiated after the Ethics in Human Research Committee at the Federal University of Ceará approved the project (protocol 44/07). All the participants, themselves and their parents or legal guardians, were asked to sign a free and informed consent form.

RESULTS

Most of the adolescents, 57.3%, were female and the average age was 14.5 years old: 53.4% between 12 and 14 years old. In relation to their grade, 43.6% were between the 8th and 9th grade. Students from the 6th grade up to the last year of high school participated in the study.

In relation to family income, the minimum wage at the time of the study was approximately USD $185.00. Around 11.6% of the parents/legal guardians did not answer this question. A similar percentage represented those with monthly income below one times the minimum wage; the income of 57.1% was between one and four times the minimum wage and 4.3% had more than 12 times the mini-

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mum wage. Considering that these families have their children in private schools, these results might indicate that some omitted their real income, afraid of urban violence; others may have higher but not proven income or yet a variable income, and others may either have their tuition paid by another family member or have a tuition waiver. Additionally, private schools that consented to participate in the study were small and their tuition rates were considered low in relation to larger schools.

Most (94.1%) of the students did not work, which seems to be related to the students' age and also to the Brazilian northeastern culture inherited from their ancestors, which indicates that children should not work until they conclude high school since it may harm school performance and their success in the university selection tests (Table 1).

Table 1 - Characteristics of adolescents from private schools according to socio-demographic variables - Fortaleza, CE, Brazil - 2007

Variables	N	%	Statistics
Gender			CI - 95%
Female	455	57.3	53.8% - 60.8%
Male	339	42.7	39.2% - 46.2%
Age Group			Average: 14.5 SD: 1.57
12 to 14 years old	424	53.4	Minimum: 12 Maximum: 17.5
15 to 17 years old	370	46.6	P25:13.5 P50: 14.5 P75: 16
Grade			CI - 95%
6th e 7th ano	123	15.5	13.1% - 18.2%
8th e 9th ano	346	43.6	40.1% - 47.1%
1st, 2nd e 3rd ano	325	40.9	37.5% - 44.5%
Income*			
< 1 times minimum wage	92	11.6	Average: 4.02 DP: 3.80
1 – 4 times minimum wage	453	57.1	Minimum: 1.0 Maximum: 30.0
4,1 – 8 times minimum wage	173	21.8	P25: 2.0 P50: 3.0 P75: 5.0
8,1 – 12 times minimum wage	42	5.3	
>12 times minimum wage	34	4.3	
Nº of people in the residence			
Did not answer	10	1.3	0.6% - 2.4%
1 – 5	656	82.6	79.8% - 85.2%
6 – 10	125	15.7	13.3% - 18.5%
> 10	3	0.4	0.1% - 1.2%
With whom they live			
Did not answer	5	0.6	0.2% - 1.6%
Parents	657	82.7	79.9% - 85.3%
Grandparents	50	6.3	4.8% - 8.3%
Uncles	22	2.8	1.8% - 4.2%
Others	60	7.6	5.9% - 9.7%
Mothers works			
Did not answer	42	5.3	3.9% - 7.1%
Yes	471	59.3	55.8% - 62.7%
No	281	35.4	32.1% - 38.8%
Fathers works			
Did not answer	96	12.1	9.9% - 14.6%
Yes	614	77.3	74.2% - 80.2%
No	84	10.6	8.6% - 13.0%
Student works			
Did not answer	16	2.0	1.2% - 3.3%
Yes	31	3.9	2.7% - 5.6%
No	747	94.1	92.1% - 95.6%

* Minimum wage was approximately USD $185.00 in April 2007.

In relation to DM2 risk factors investigated in this study, Table 2 shows the number of adolescents exposed to the

risk of acquiring the disease according to each factor. According to the BMI classification of 794 adolescents, 23.7% of them displayed a high index: 19.9% were classified as overweight and 3.8% as obese. In relation to the practice of exercise we observed that 65.1% were sedentary. Another finding was that 9.7% of the adolescents had blood pressure level out of levels considered normal: 10.1% of these were included in the limitrophe category and 9.6% were hypertensive in stage I. The glucose levels of only 5% were considered dubious according to the Ministry of Health (Table 2).

Table 2 - Distribution of risk factors for type 2 diabetes mellitus in adolescents from private schools - Fortaleza, CE, Brazil - 2007

Variables	N	%	CI – 95%
BMI			
Normal	606	76.3	73.2% - 79.2%
Overweight	158	19.9	17.2% - 22.9%
Obesity	30	3.8	2.6% - 5.4%
Exercises			
Yes	277	34.9	31.6% - 38.3%
Not	517	65.1	61.7% - 68.4%
Blood pressure			
Normal	638	80.4	77.4% - 83.0%
Limirophe	80	10.1	8.1% - 12.4%
Hypertension	76	9.6	7.7% - 11.9%
Capillary glucose			
Normal	755	95.1	93.3% - 96.4%
Dubious exam*	39	4.9	3.6% - 6.7%
Dm2 antecedents in 1st and 2nd degree relatives			
Did not answer	61	7.7	6.0% - 9.8%
Yes	406	51.1	47.6% - 54.7%
No	327	41.2	37.7% - 44.7%
Total	794	100.0	---

* Dubious exam (141 to 199mg/dl).

In addition to the already mentioned factors, DM2 family history is also considered a risk factor that predisposes adolescents to DM2. According to Table 2, diabetes was observed in 51.1% of 1st and 2nd degree relatives, bearing in mind that 7.7% of the parents/legal guardians did not answer this item in the questionnaire. A prevalence of DM2 in 9.7% of parents was observed, 0.8% in siblings, and 48% in the students' grandparents. This last information is supported by specific literature that reveals a direct association between aging and DM2 onset[10].

Among the students from families with higher incomes, 73.5% had a history of DM2 in the family (p=0.04); 82.8% of the adolescents who displayed dubious glycemia results did not have a history of DM2 in the family (p=0.54) (Table 3).

Five risk factors for DM2 were evaluated: being overweight, sedentariness, DM2 antecedents in 1st and 2nd degree relatives, high blood pressure and high levels of capillary glucose. In relation to the number of risk factors present for each adolescent, 10.5% did not display any of the investigated factors and were not at the risk of developing DM2. However, 33.8% of the participants had at least one factor; 39.2% had two; 14.2% had three factors; and 2.3% had four associated factors (Table 4).

Table 3 - Association of the risk factor antecedents of diabetes in 1st and 2nd degree relatives with gender, age, grade, income, physical exercises, blood pressure and glycemia in adolescents. Fortaleza, CE, Brazil - 2007

	DM 2 Family Antecedents				p**
	Yes		No		
	N	%	N	%	
Gender					
Male	171	54.5	143	45.5	
Female	235	56.1	184	43.9	0.35
Age					
12-14 years old	217	55.1	177	44.9	
15-17 years old	189	55.8	150	44.2	0.45
Income					
< 1 times min wage*	41	51.3	39	48.7	
1-4 times min wage	217	52.0	200	48.0	
4.1-8 times min wage	100	61.3	63	38.7	0.04
8.1-12 times min wage	23	59.0	16	41.0	
> 12 times min wage	25	73.5	9	26.5	
Exercises					
Yes	25	10.1	223	89.9	0.45
No	52	11.4	405	88.6	
Glycemia					
Normal	72	10.7	604	89.3	
Dubious***	5	17.2	24	82.8	0.54
Blood Pressure					
Hypertensive	7	10.8	58	89.2	
Limitrophe	5	6.8	69	93.2	0.27
Normal	65	11.5	501	88.5	
BMI					
Normal	55	10.2	483	89.8	
Overweight	4	15.4	22	84.6	0.13
Obesity	18	12.8	123	87.4	

*Minimum wage was approximately USD 185 in April 2007
**(Chi-square test)
*** Dubious (141 to 199mg/dl)

Table 4 - Distribution of the number of risk factors for DM2 for each participant - Fortaleza, CE, Brazil - 2007

Number of risk factors for DM2	N	%	CI – 95%
None	83	10.5	8.5% - 12.8%
1	268	33.8	30.5% - 37.2%
2	311	39.2	35.8% - 42.7%
3	113	14.2	11.9% - 16.9%
4	18	2.3	1.4% - 3.6%
5	1	0.1	0.0% - 0.8%
Total	**794**	**100.0**	--

DISCUSSION

The Center for Disease Control and Prevention estimates that one in three American children will develop the disease. Considering an epidemic of large proportion, the American Diabetes Association established criteria to classify children and adolescents at risk of developing DM2: overweight/obesity with BMI above or at the 85th percentile and two or more other DM2 risk factors (DM2 family history, high risk related to race/ethnicity, insulin resistance, hypertension and acanthosis nigricans)[13] .

However, the characterization of degree of risk is not standardized. For an asymptomatic individual to be a suspected case and be granted a laboratorial evaluation, some suggest that various risk factors need to be present. The growing tendency is to use one score of risk factors similar to those used to evaluate cardiovascular risk[14]. The score to be adopted in Brazil will be probably determined in the next manual of primary care in DM[10].

Only two studies addressing risk factors in children and adolescents were identified: one indicated that 40% of the students displayed two or more DM2 risk factors and the other study found that 33%, 7.5% and less than 1% displayed two, three and all the risk factors, respectively[3,6]. This study revealed that 33.8% had at least one risk factor, 39.2% two, 14.2% three; and 2.3% displayed four risk factors, showing that students from private schools in Fortaleza, CE are more vulnerable to DM2 than those in public schools[6].

This study showed a rate of being overweight at 24.7%, which in addition to favoring the onset of DM2, was higher than percentages found in other studies[15-16]. Sedentariness was considered high among the study participants (65.1%), which was considered low in students from public schools[6]. The percentage of individuals with values indicating hypertension is a concern, though it is below those found in a similar study[15].

A total of 80% of children and adolescents who develop DM2 have one parent with diabetes and 90% have some relative with the disease[3]. Studies indicate a genetic connection for DM2 development[17-19]. One study carried out with children and adolescents in Kuwait found a statistically significant (p=0.004) association between DM2 in this population and DM2 family history[20]. Additionally, adolescents who have a maternal antecedent of DM2 have 3.10 times more chances of developing the disease compared with a paternal antecedent (2.54)[18], though contradictory results have been found in other studies whose ethnical groups present a high prevalence of the disease[3,6].

In relation to issues related to DM2 family history, this study's results were lower than those presented by another study[6]. These findings might be explained by the different conditions in which the study was carried out and by the fact many parents did not answer the question addressing this subject. More than 11% and 13.4% of the parents did not answer whether there were antecedents of diabetes in parents and siblings, respectively. These percentages are higher than of those who reported the disease, which contributed to the difference found in relation to other studies.

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It is currently evident that individuals at a high risk of acquiring the disease can prevent, or at least delay, the onset of DM2. Changes in lifestyle reduced 58% of the incidence of diabetes in three years. These changes aimed to slightly reduce weight (5-10% of weight), maintenance of weight lost, increased consumption of fiber, moderate energetic restriction, restriction of fat, especially saturated fats, and increased regular physical exercise[10].

Even though there is not a defined standard concerning DM2 risk factors and their respective relevance, researchers state that the higher the number of risk factors, the higher the probability of acquiring the disease[21]. Hence, it is necessary that actions be devised to avoid the growth of the disease among young people and integrated by health professionals and public policies.

Additionally, given the increased prevalence of DM2 among the Brazilian population, health professionals need to pay attention to risk factors so that educational, prevention and health promotion actions to cope with this problem are in agreement[22].

CONCLUSION

The most prevalent risk factors among the studied adolescents were being overweight and sedentariness. These are modifiable factors and therefore play an important role in the prevention of DM2. Additionally, the study added important information to knowledge concerning the prevalence of risk factors for the development of DM2 among adolescents, still scarce in the literature. The results indicate opportunities for nurses, who in addition to providing care to patients, should extend their field of action to the prevention of diseases and health promotion in the population in general. Therefore, another field is open for nurses to propose to schools the implementation of educational workshops aiming primarily to fight modifiable risk factors for DM2.

Regarding the identification of DM2 risk factors, the variety of criteria found in the literature to classify, mainly BMI and blood pressure, indicates the need to carry out studies using different criteria than those used in this study so as to compare the results and determine more sensitive and specific criteria to analyze these variables in the young population.

It is worth noting the lack of sensitivity of some parents and legal guardians to answer the questionnaire, which hindered more complete data collection, and resulted in a limitation on the study. The difficulties found selecting schools indicate that those interested in developing studies in the private school system should plan and implement actions based on the obtained results that can benefit schools and also promote discussions with parents and principals that inform them of the benefits that accrue from studies of this nature.

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