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PERMANYER

Gac Med Mex. 2016;152:565-73

GACETA MÉDICA DE MÉXICO

ORIGINAL ARTICLE

Prevalence of impaired fasting glucose in a working population of Spanish Mediterranean area: influence of sociodemographic variables and healthy habits

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Abstract

Introduction: *The impaired fasting glucose (IFG) is an intermediate clinical situation between normal glucose and type 2 diabetes, it is known that 25% of people with IFG progress to type 2 diabetes.* **Methods:** *Descriptive study in 60,798 Spanish workers. The IFG was determined using the American Diabetes Association (ADA) criteria: 100-125 mg/dl and the World Health Organization (WHO) criteria: 110-125 mg/dl. The influence of sociodemographic variables (age, sex, social class, studies class) and healthy habits (tobacco, alcohol consumption, physical activity, feeding) were evaluated in the IFG prevalence.* **Results:** *The IFG prevalence was 3.3% (1.8% in women and 4.5% in men) using the WHO criteria and 11.8% (7% in women and 15.4% in men) using the ADA criteria. The IFG is more common in men and increases with age. People with low socioeconomic status (social classes IV and V, blue collar and primary studies) and poor health habits (smokers, heavy alcohol consumption and low physical activity) have a higher prevalence.* **Conclusions:** *The sociodemographic variables and the healthy habits, except consumption of fruits and vegetables, influence the prevalence of IFG.* (Gac Med Mex. 2016;152:565-73)

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KEY WORDS: *Impaired fasting glucose. Prediabetes. Sociodemographic factors. Healthy habits. Occupational health.*

Introduction

Type-2 diabetes (DM2) is one of the most important health problems in our setting. We can speak about a situation that is almost epidemic, since currently there are nearly 250 million of people with this disease in the world, which will reach to be almost 400 million in 10 years.

Prediabetes is a clinical condition that includes impaired fasting glucose (IFG), impaired glucose tolerance (IGT) or both conditions simultaneously, and it is associated with an elevated risk for the development of DM2 and with cardiovascular complications[1,2]. The cutoff values to define IFG are different for the World Health Organization (WHO), between 110 and 125 mg/dl, and for the American Diabetes Association (ADA), between 100 and 125 mg/dl[1]. Prediabetes can also be

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Date of reception: 24-07-2015
Date of acceptance: 27-07-2015

defined according to the glycated hemoglobin values, which range from 5.7% to 6.4% for the ADA and from 6% to 6.4% for the National Institute for Health and Care Excellence[3], or if the values of the Findrisc test values are used, there is also no consensus cutoff point, since some authors establish it from 9[4] and others from 15 onwards[5-7].

People with prediabetes are more likely to develop DM2, with risk increasing between 5% and 20% per year in prediabetics versus 0.7% annually for people with normal blood glucose. People who have IFG and IGT simultaneously have double possibilities to develop DM2 than those with only one of both conditions[3]. One fourth part of prediabetics has been observed to progress to diabetes, another fourth part returns to a normal situation and 50% remain in a prediabetic situation[8].

The purpose of this study was to find out the prevalence of IFG in the working population and which socio-demographic variables and healthy habits influence on it.

Material and methods

Type of study

Cross-sectional, descriptive study in 60,798 workers (25,972 women and 34,826 men) from the Spanish Mediterranean area belonging to different productive sectors. A total of 1,757 workers (462 women and 1,295 men) with a previous diagnosis of diabetes were excluded from the work; therefore, total sample is comprised by 59,041 workers (25,510 women and 33,531 men).

Working protocol

The sample has been obtained from medical examinations carried out in the different participating companies during the period comprised between January 2011 and December 2013. All the workers included in this study belong to the same medical department and, therefore, the methodology employed has been the same for all cases and the laboratory where the tests have been performed is the same. In the different participating Occupational Health units, each worker, and the Safety and Health Committees were informed, as indicated by current legislation, on the characteristics and purposes of the study and, once accepted, history was taken as thoroughly as possible, including personal and family past history, previous treatments, occupational data and collection of clinical data such as weight, height, body mass index (BMI), waist circumference, blood pressure, healthy habits, as well as the corresponding laboratory tests.

Determination of variables

The BMI was obtained by means of the Quetelet index. Height and weight were determined using standardized scales-stadiometers. Abdominal waist circumference was calculated with a measuring tape placed in parallel to the floor at the level of the last floating rib, i.e., the natural waist contour, located between the upper part of the hip bone (iliac crests) and the lower rib, is measured during normal breathing with the subject in the standing position and with relaxed abdomen.

Total cholesterol and triglycerides were determined by automated enzyme methods, HDL-C was determined by precipitation with dextran sulfate-MgCl2, LDL-C was calculated with the Friedewald formula (as long as triglycerides were lower than 400 mg/dl) and glucose with an enzyme method. Blood extraction was carried on the same session of medical examination and at the same place, after 12-hour nocturnal fasting. The samples were sent to the reference laboratory and were processed in a maximum of 48-72 hours and preserved at a temperature of -20 °C.

Blood pressure was determined after a 10-minute rest period in the supine position using a calibrated automatic OMRON M3 sphygmomanometer.

To define IFG, both the WHO (110-125 mg/dl) and the ADA criteria (100-125 mg/dl) are used.

Age is classified in 5 groups: 20-29 years, 30-39 years, 40-49 years, 50-59 years and 60-69 years. The level of education establishes 3 categories: primary (basic education or no education), secondary (high-school or professional training) and college education. Social class and type of work are determined based on the national classification of occupations of the year 2011 (CNO-2011 – *Clasificación Nacional de Ocupaciones del año 2011)* and taking into account the classification established by the Spanish Society of Epidemiology[9].

Alcohol consumption is considered when 3 standard beverage units (SBU) per day are exceeded in men and 1.5 in women, taking into account that one SBU is equivalent to 10 grams of alcohol. Physical activity is considered when at least 30 minutes per day are regularly practiced or 4 weekly hours both at work and on leisure time. Nutrition is considered to be adequate when fruits and vegetables are consumed every day.

Table 1. Sample characteristics

	Women (n = 25,510)			Men (n = 33,531)			
	Mean	SD	Median	Mean	SD	Median	p
Age	39.3	10.1	39.0	40.0	10.3	40.0	< 0.0001
BMI	24.9	4.8	23.9	26.8	4.2	26.3	< 0.0001
Waist c.	75.2	9.7	74.0	88.4	9.5	87.0	< 0.0001
Waist/height index	0.47	0.06	0.46	0.51	0.06	0.50	< 0.0001
SBP	114.4	14.9	110.0	124.9	15.4	120.0	< 0.0001
DBP	70.3	10.3	70.0	75.8	10.7	76.0	< 0.0001
Cholesterol	192.8	36.4	190.0	196.7	38.6	195.0	< 0.0001
HDL	55.0	9.2	54.0	50.7	7.5	51.0	< 0.0001
LDL	120.4	36.9	118.9	121.8	37.2	120.8	< 0.0001
Triglycerides	87.0	43.8	78.0	123.2	85.8	101.0	< 0.0001

Subjects who have smoked daily any number of cigarettes during the last month are regarded as smokers.

Statistical analysis

In the descriptive analysis, once normal distribution was verified with the Kolmogorov-Smirnov method, mean value, standard deviation and median value were used. For the parametric bivariate analysis, the mean difference was used (Student's t-test). The chi-square test with 95% confidence interval was used for the verification of proportions. The multivariate analysis was carried out by means of multinomial logistic regression. In all cases, statistical significance was established at a p-value < 0.05. The analyses were performed using the SPSS 20.0 statistical package.

Results

The prevalence of IFG is 3.3% (1.8% in women and 4.5% in men) if we use 110 mg/dl as cutoff point and 11.8% (7% in women and 15.4% in men) if the cutoff point goes down to 100 mg/dl.

The characteristics of the sample with regard to anthropometric, clinical and laboratory parameters are shown in table1. Table 2 shows the distribution of different socio-demographic variables and healthy habits among men and women. In both cases, statistically significant differences are observed to exist by gender and thus the remaining results will be presented separately for men and women.

The prevalence of IFG, either when we establish the cutoff point at 100 mg/dl or at 110 mg/dl, shows a progressive increase of the values as the workers' age increases, and this occurs both in women and in men. Values in younger women range from 0.3% or 1.3%, depending on the cutoff point, to 7.8% and 13.3% in the older age group. In males, prevalences range from 2.6% and 7% in young men to 21.5% and 33.9% from 60 years of age onwards. The complete data are presented in table 3.

Both in men and women, regardless of the cutoff point, most favored social classes (I and II) are observed to exhibit lower IGF prevalence, whereas most underprivileged classes (IV and V) show the highest values. There is practically a direct relationship between social class and IGF prevalence. Something similar happens with the type of work, where blue-collar workers show higher IGF prevalences. Continuing with socioeconomic status-related data, we observe that workers with lower level of education, i.e., those with primary education, show higher IGF prevalence, whereas those with college education exhibit the lowest prevalences. When we assess healthy habits, we observe that especially alcohol consumption, but also low physical activity and fruit and vegetable-poor diet are associated with higher IGF prevalence, with the differences being statistically significant. In turn, tobacco consumption doesn't show an influence on the presence or not of IGF. All these data are shown in table 3.

When the results are globally analyzed in both genders taking into account the different age groups a

Table 2. Distribution of socio-demographic variables and healthy habits in our sample

	Women (n = 25,510)	Men (n = 33,531)	p
20-29 years	19.5	17.5	< 0.0001
30-39 years	32.7	32.4	
40-49 years	30.2	29.9	
50-59 years	15.3	17.2	
60-69 years	2.4	3.0	
Class I	6.6	3.8	< 0.0001
Class II	7.7	3.6	
Class III	32.7	23.5	
Class IV	28.7	58.3	
Class V	24.3	10.8	
Blue-collar	53.0	69.1	< 0.0001
Non-blue collar	47.0	30.9	
Primary education	47.4	69.9	< 0.0001
Secondary education	40.2	23.6	
College education	12.4	6.5	
Non-smokers	67.4	63.3	< 0.0001
Smokers	32.6	36.7	
Alcohol no	93.2	83.5	< 0.0001
Alcohol yes	6.8	16.5	
Physical exercise no	47.2	55.0	< 0.0001
Physical exercise yes	52.8	45.0	
Nutrition no	48.9	59.2	< 0.0001
Nutrition yes	51.1	40.8	

clear trend is observed, in such a way that with increasing age, the prevalence of IFG increases regardless of the established cutoff point and, in addition, the values are higher in men.

The observed differences are in general statistically significant at central ages, between 30 and 59 years both in men and women, except with regard to tobacco consumption. At extreme ages, less than 30 and from 60 years on, the presence of statistically significant differences is lower. All data are presented in tables 4 A and B.

The logistic regression multivariate analysis establishes the most disfavored subsets as reference groups: male gender, age between 60-69 years, social class V, primary education, smokers, alcohol consumers, people with no regular physical activity and nutrition poor in fruits and vegetables. Odds ratios (OR) are established with their confidence intervals, and when the cutoff point is established at 110 mg/dl, statistically significant differences are observed by age (OR: between 1.38; CI: 1.15-1.65, and 7.21; CI: 5.51-9.43), gender (OR: 1.96; CI: 1.74-2.21), tobacco consumption (OR: 1.60; CI: 1.45-1.78), alcohol consumption (OR: 4.82; CI: 4.30-5.40) and some social classes (I and III), as well as secondary education. When the cutoff point is 100 mg/dl, differences appear for age (OR: between 1.47; CI: 1.30-1.67, and 5.09; CI: 4.41-5.88), gender (OR: 2.10; CI: 1.97-2.23), social class (OR: between 1.08; CI: 1.00-1.16, and 1.67; CI: 1.17-2.39), tobacco consumption (OR: 1.12; CI: 1.06-1.19), alcohol consumption (OR: 1.83; CI: 1.71-1.96) and college ed-

Table 3. IGF prevalence by gender and according to socio-demographic variables and healthy habits taking into account both cutoff points

	Women				Men			
Blood glucose	**110-125**	**p**	**100-125**	**p**	**110-125**	**p**	**100-125**	**p**
20-29 years	0.3	< 0.0001	2.6	< 0.0001	1.3	< 0.0001	7	< 0.0001
30-39 years	0.8		4.3		2.4		10.7	
40-49 years	2		8.3		4.8		17.8	
50-59 years	4.4		13.6		9.6		25.6	
60-69 years	7.8		21.5		13.3		33.9	
Class I	0.8	< 0.0001	4.1	< 0.0001	1.3	< 0.0001	11.1	< 0.0001
Class II	1.4		4.5		2.5		11.1	
Class III	1		5.8		3.4		13.3	
Class IV	1.3		6.1		5.2		16.6	
Class V	3.7		11.4		4.9		15.9	
Blue-collar	2.4	< 0.0001	8.5	< 0.0001	5.1	< 0.0001	16.7	< 0.0001
Non-blue-collar	1.1		5.3		3		12.8	
Primary education	2.5	< 0.0001	9.1	< 0.0001	5.1	< 0.0001	16.5	< 0.0001
Secondary education	1.1		5.4		3.3		13.4	
College education	1		4.2		2		11.6	
Non-smokers	1.8	0.112	7.3	0.018	4.4	0.103	15.6	0.204
Smokers	1.6		6.5		4.7		15.2	
Alcohol no	0.8	< 0.0001	4.6	< 0.0001	2.9	< 0.0001	14.1	< 0.0001
Alcohol yes	15.2		40.5		12.4		22.3	
Physical exercise no	3	< 0.0001	10.8	< 0.0001	6.4	< 0.0001	20.2	< 0.0001
Physical exercise yes	0.7		3.7		2.1		9.6	
Nutrition no	2.9	< 0.0001	10.4	< 0.0001	6.2	< 0.0001	19.4	< 0.0001
Nutrition yes	0.7		3.8		2.1		9.6	

ucation (OR: 1.13: CI: 1.03-1.23). The complete data set is presented in table 5.

Discussion

The prevalence of IFG obtained in our study when the cutoff point is 110 mg/dl is 3.3%, and is similar to that obtained in the Di@bet.es study[10], also conducted in Spanish population and using the same cutoff point, where prevalence was established at 3.4%.

Our work has shown a direct influence of age on the onset of IFG, with groups aged 50 years and older therefore showing more elevated prevalences; these data are consistent with those obtained by Clair[11] in the year 2013 in USA population, by Boucher[12] in African population of both ethnicities and by Gupta[13] in population of India.

Women in our sample show greater likelihood to develop IFG, with these data being similar to those obtained by Hilawe[14] in sub-Saharan population.

People with the worst socioeconomic status, i.e., those belonging to the most underprivileged social classes (IV and V), who are blue-collar workers and have primary level of education, are the ones that in our study show higher prevalence of IFG, a situation that is repeated in other reviewed studies[15,16].

Table 4. A: IFG prevalence in women by age and according to socio-demographic variables and healthy habits taking into account both cutoff points

	20-29 y				30-39 y				40-49 y				50-59 y				60-69 y			
Blood glucose	**110-125**	**p**	**100-125**	**p**	**110-125**	**p**	**100-125**	**p**	**110-125**	**p**	**100-125**	**p**	**110-125**	**p**	**100-125**	**p**	**110-125**	**p**	**100-125**	**p**
Class I	0.3	0.053	1.3	0.056	0.3	0.008	2	<0.0001	1.9	<0.0001	7.9	<0.0001	2.1	<0.0001	9.9	0.031	0	0.314	5.9	0.412
Class II	0.6		3.3		1		2.9		1.7		5.9		5.6		10.5		0		19	
Class III	0.1		3		0.5		4.2		1.1		6.2		2.9		12.3		6.7		20.1	
Class IV	0.2		2.1		0.7		3.9		1.7		7.7		3.1		12.7		7.4		19.9	
Class V	0,8		3.6		1.4		6.9		3.4		12		6.2		15.6		9.6		24	
Blue-collar	0.3	0.492	2.5	0.259	1	0.015	5.1	0.001	2.6	<0.0001	9.9	<0.0001	5	0.005	15,9	0.012	8.9	0.088	14.5	0.162
Non-blue-collar	0.3		2.8		0.6		3.7		1.3		6.3		3.1		10.2		5.2		11.8	
Primary education	0.2	0.693	2.5	0.777	1	0.1	5.6	<0.0001	2.7	<0.0001	10.4	<0.0001	5.3	0.001	15.2	<0.0001	8.5	0.264	22.3	0.587
Secondary education	0.3		2.7		0.6		3.8		1.2		6		2.8		11.4		7.5		20.8	
College education	0.4		2.9		0.6		2.7		1.7		6.5		3		8.7		0		14.3	
Non-smokers	0.3	0.504	2.7	0.425	0.8	0.321	4.3	0.523	1.9	0.220	8.1	0.229	4.5	0.288	14.1	0.119	7.4	0.210	21.1	0.310
Smokers	0.3		2.6		0.7		4.3		2.2		8.6		4		12.2		10.8		24.3	
Alcohol no	0.2	<0.0001	2.2	<0.0001	0.5	<0.0001	3.3	<0.0001	1	<0.0001	5.6	<0.0001	1.7	<0.0001	8	<0.0001	3.6	<0.0001	12.9	<0.0001
Alcohol yes	7.3		29.3		12.3		42.7		14.6		42.2		16.2		38.5		20.4		46.7	
Physical exercise no	0.7	0.003	4	<0.0001	1.4	<0.0001	6.9	<0.0001	2.9	<0.0001	11.2	<0.0001	5.2	<0.0001	16	<0.0001	8.9	0.026	24.3	<0.0001
Physical exercise yes	0.1		2.1		0.4		2.7		0.9		5		2.3		7.8		3.4		10.1	
Nutrition no	0.6	0.006	3.7	0.001	1.3	<0.0001	6.6	<0.0001	2.8	<0.0001	11	<0.0001	5.1	<0.0001	15.7	<0.0001	9.1	0.015	24.1	0.001
Nutrition yes	0.1		2.1		0.4		2.8		1		5.1		2.4		8.3		3.1		11.8	

Table 4. B: IFG prevalence in women by age and according to socio-demographic variables and healthy habits taking into account both cutoff points

	20-29 y				30-39 y				40-49 y				50-59 y				60-69 y			
Blood glucose	**110-125**	**p**	**100-125**	**p**	**110-125**	**p**	**100-125**	**p**	**110-125**	**p**	**100-125**	**p**	**110-125**	**p**	**100-125**	**p**	**110-125**	**p**	**100-125**	**p**
Class I	0	0.048	5.2	0.012	0.2	<0.0001	5.3	<0.0001	1.2	<0.0001	15.4	<0.001	4.2	<0.0001	18.4	<0.0001	7.1	0.712	23.8	0.234
Class II	0		3.4		1.1		6.6		3		15.3		7.4		23.5		16.2		48.6	
Class III	0.9		5.4		1.2		8.5		3.1		13.8		7.6		21.9		12.2		34.2	
Class IV	1.6		7.7		3.1		12.2		5.7		19.9		11		27.7		13.7		33.5	
Class V	1.2		7.2		2.9		11.7		6.1		18.4		9.2		26.1		14.4		34.4	
Blue-collar	1.5	0.003	7.6	<0.0001	3.1	<0.0001	12.1	<0.0001	5.7	<0.0001	19.7	<0.0001	10.7	<0.0001	27.4	<0.0001	13.8	0.247	33.7	0.421
Non-blue-collar	0.6		4.9		1		7.8		2.9		14.1		7.2		21.6		12		34.6	
Primary education	1.5	0.032	7.5	0.009	3.1	<0.0001	12	<0.0001	5.6	<0.0001	19.4	<0.0001	10.5	<0.0001	26.7	0.008	14.1	0.456	34	0.966
Secondary education	0.9		5.4		1.2		8.5		3.2		14.2		7.8		23.4		11.4		33.5	
College education	0		4.5		0.6		6.1		2		15.2		5.6		20.8		10.8		35.1	
Non-smokers	0.9	0.002	6.8	0.318	2.1	0.001	10.1	0.002	4.4	0.021	17.5	0.189	9.6	0.436	26	0.184	13.2	0.498	33.4	0.278
Smokers	1.8		7.2		3.1		11.8		5.4		18.3		9.5		24.8		13.4		35.7	
Alcohol no	1.3	0.504	7	0.508	1.9	<0.0001	10.5	0.004	3.4	<0.0001	16.8	<0.0001	6.1	<0.0001	24.1	<0.0001	8.1	<0.0001	33.9	0.515
Alcohol yes	1.4		6.8		7.3		13.1		11.1		22.1		17.5		28.8		20.7		34	
Physical exercise no	1.8	0.033	10	<0.0001	1.4	<0.0001	13.8	<0.0001	6.2	<0.0001	21.1	<0.0001	11.1	<0.0001	28.4	<0.0001	14.7	0.010	35.2	0.071
Physical exercise yes	1.1		5.7		0.4		7.9		2.3		11.9		5.5		17.9		8.6		29.7	
Nutrition no	1.8	0.011	9.4	<0.0001	3.2	<0.0001	13.3	<0.0001	6	<0.0001	20.5	<0.0001	10.8	<0.0001	27.7	<0.0001	14.7	0.008	35.1	0.095
Nutrition yes	1.1		5.7		1.6		7.9		2.1		11.7		5.7		18.7		8.4		30.1	

Table 5. Multivariate analysis according to both IFG cutoff points

	110-125			100-125		
	Odds ratio	**95% CI**	**p**	**Odds ratio**	**95% CI**	**p**
Woman	1.96	1.74-2.21	< 0.0001	2.10	1.97-2.23	< 0.0001
20-29 years	7.21	5.51-9.43	< 0.0001	5.09	4.41-5.88	< 0.0001
30-39 years	3.99	3.26-4.87	< 0.0001	3.41	3.01-3.86	< 0.0001
40-49 years	2.29	1.90-2.75	< 0.0001	2.09	1.85-2.35	< 0.0001
50-59 years	1.38	1.15-1.65	0.001	1.47	1.30-1.67	< 0.0001
Class I	2.53	1.23-5.19	0.012	1.67	1.17-2.39	0.005
Class II	1.20	0.67-2.15	0.549	1.40	1.02-1.91	0.036
Class III	1.74	1.42-2.13	< 0.0001	1.34	1.20-1.50	< 0.0001
Class IV	1.14	0.99-1.30	0.051	1.08	1.00-1.16	0.048
Secondary education	1.21	1.02-1.43	0.026	1.04	0.74-1.44	0.834
College education	1.39	0.74-2.63	0.308	1.13	1.03-1.23	0.011
Non smokers	1.60	1.45-1.78	< 0.0001	1.12	1.06-1.19	< 0.0001
Alcohol no	4.82	4.30-5.40	< 0.0001	1.83	1.71-1.96	< 0.0001
Physical exercise yes	1.20	0.95-1.52	0.119	1.52	1.36-1.70	< 0.0001
Nutrition yes	1.15	0.91-1.45	0.258	1.12	0.99-1.25	0.051

Among the healthy habits we found that the smokers in our sample show greater predisposition to develop IFG, and this finding is consistent with those of the meta-analysis by Willi[17], where 25 different studies were analyzed, and with the works by Clair[11], Abunassar[18], Nakanishi[19] in Japanese middle-aged males and Park[20] in Korean population. Regular physical activity has shown in our study to be a protective factor against the onset of IFG, with these data being similar to those obtained by Boucher[12] and Hesselink[21], although the works by the latter included a physical activity and nutrition mixed program.

Fruit and vegetables-rich nutrition has not demonstrated real influence on the prevalence of IFG, especially in females, since data on men are at the border of statistical significance. This lack of influence of nutrition has also been observed in other reviewed studies, such as the meta-analysis by Cooper[22], where the results were inconclusive; however, the work conducted by Mursu[23] in Finnish males shows how a diet rich in fruit and vegetables reduces the risk for suffering from DM2.

Finally, excessive consumption of alcohol in our study is strongly associated (elevated ORs) with the onset of IFG. In the reviewed literature, the effect of moderated doses of alcohol on the appearance of IFG is mainly assessed, with data being discrepant; thus, authors such as Marqués-Vidal[24] do not find a relationship, while others such as Nakanishi[25] do find it, although in studies carried out in middle-aged Japanese males.

Conflict of interests

There isn't any conflict of interests.

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