

# Predictive factors of impaired glycaemic state in community-dwelling older adults in Brazil

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## Article points

1. In this cross-sectional study, potential factors associated with impaired glycaemic state (IGS) were explored in a cohort of 316 people aged  $\geq 60$  years in Brazil.
2. In the final logistic regression model, IGS was found to be associated with waist circumference in men and BMI in women.
3. Cut-off points of  $>101$  cm for waist circumference and  $29 \text{ kg/m}^2$  for BMI had moderate sensitivity but high specificity for IGS.

## Key words

- Ageing
- Diabetes
- Risk factors

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**This study aimed to identify and analyse predictive factors for impaired glycaemic state (IGS) in community-dwelling old adults, in order to create a predictive model for this population. Data from 316 community-dwelling older adults ( $\geq 60$  years) were analysed, with IGS as the dependent variable and age and anthropometric and motor performance indicators as predictor variables. In the resulting model, only waist circumference for men and BMI for women were significant predictors of IGS.**

The ageing process is associated with an increased prevalence of impaired glycaemic state (IGS), a collective term that includes impaired fasting glucose (i.e. fasting blood glucose levels of 5.6–6.9 mmol/L) and diabetes (Danaei et al, 2011; American Diabetes Association, 2014). Alarming, the global prevalence of diabetes and/or IGS is increasing, with high impact in developing countries (Danaei et al, 2011; Schmidt et al, 2015). Recent surveys suggest that approximately 9 million Brazilians have diabetes, and around 3.5 million of these are aged 65 years or over (Iser et al, 2015).

Diabetes is one of the most common causes of mortality and morbidity in the world, increasing the risk of death from cardiovascular and kidney disease. The development of diabetes among older adults is associated with accelerated functional decline (Schaap et al, 2013; de Rekeneire and Volpato, 2015); changes in body composition, especially reductions in muscle mass and increases in adipose tissue (Koster and Schaap, 2015); and cardiovascular complications, such as hypertension (Nayak et al, 2014), all of which are typical features of the ageing process. The close relationship of these changes with the pathogenesis of diabetes could help the identification of older people who have IGS.

From this perspective, the identification of predictors of IGS may be an affordable alternative to facilitate screening, with a view to early diagnosis of IGS in the older population. It may also enable the adoption of preventive strategies and early intervention by health services in order to improve the health of older people, especially in communities with low indicators of health and quality of life, where the cost of conducting biochemical tests for the entire population is prohibitive. Thus, this study was performed to identify and analyse predictive factors for IGS in community-dwelling older adults, in order to create a predictive model of IGS for this population.

## Methods

This was a descriptive study with a cross-sectional design, conducted by the Center for Research on Epidemiology of Aging at the State University of Southwest Bahia, Brazil. The study was conducted in the municipality of Lafaiete Coutinho. During the data collection period, the population consisted of 3901 inhabitants registered in the Primary Health Care Strategy (PHCS). Of these, 2104 individuals were living in the urban area and 598 (15%) were aged  $\geq 60$  years.

The study population comprised all individuals aged  $\geq 60$  years who were not institutionalised and were living in the urban area of Lafaiete Coutinho. Of the 355 people identified, 316 (89.0%) participated in the study; 17 refusals were registered (4.8%) and 22 subjects (6.2%) were not contactable after three home visits on different days.

The research protocol was approved by the local Ethics Committee (No. 064/2010). Participation was voluntary, and individuals signed an informed consent form, according to the ethical standards required by the Helsinki Declaration.

### Data collection

Data were collected in January 2011 by the interviewers, with the support of healthcare professionals from each area of the PHCS. Data from sociodemographic questions, blood tests, blood pressure, heart rate, anthropometric measurements and motor performance tests were recorded.

### Glycaemic state (dependent variable)

The population was stratified as impaired (IGS) or normal glycaemic state (NGS) based on two criteria that did not exclude one another: fasting blood glucose  $\geq 5.6$  mmol/L and/or continuous use of insulin and/or oral hypoglycaemic drugs. The cut-off point of  $\geq 5.6$  mmol/L was adopted based on American Diabetes Association (2014) criteria.

### Anthropometric indicators (predictor variables)

The anthropometric indicators evaluated were BMI, as an indicator of general obesity; waist circumference, hip circumference and waist-to-hip ratio, as indicators of central (i.e. visceral) obesity; and arm circumference and calf circumference, as indicators of muscle mass.

### Motor performance indicators (predictor variables)

The “chair stand test” was used to assess the strength and endurance of the lower limbs, as proposed by Tinetti and Ginter (1988) and Guralnick et al (1995). The time required to perform five repetitions of rising from a chair and sitting down was recorded, and the test was considered successful when done in  $\leq 60$  seconds.

### Box 1. Details of the statistical analyses performed.

Absolute and relative frequencies and means  $\pm$  standard deviation were calculated for the descriptive analysis of participant’s characteristics. The association between the predictor variables and the dependent variable (impaired glycaemic state [IGS] vs normal glycaemic state [NGS]) was tested by multiple logistic regression with the backward LR method.

After determination of glycaemic state, the Kolmogorov–Smirnov test was used to assess normality; thereafter, unpaired Student’s *t*-tests were applied for comparisons of the predictor variables between groups (i.e. IGS vs NGS). The multiple logistic regression included only the variables of interest that achieved a *P* value of  $< 0.2$  in the *t*-test. In the multiple logistic regression, all predictor variables that met the established criteria were included in the analysis and, later, step by step, the possible combinations of variables were composed until reaching the combination that best discriminated the levels of the dependent variable, so as to obtain a final predictive model with only the remaining variables (i.e. those that remained until the end of analysis).

Adjusted models were calculated to estimate the odds ratios and their respective 95% confidence intervals. From the set of variables inserted in the final model, the logistic probability of each participant was calculated, as proposed by Dawson and Trapp (2004) and Buatois et al (2010), which allowed assessment of the final model’s predictive capacity for IGS. The logistic probability model was calculated as proposed by Dawson and Trapp (2004).

The final model’s predictive capacity for IGS and the cut-off point for higher propensity to have IGS were evaluated using the parameters provided by the receiver operating characteristic curve: area under the curve, sensitivity and specificity.

As the predictive variables were analysed in continuous data, predictive models for each gender were generated separately. In all analyses, the significance level was set at 5% ( $\alpha = 0.05$ ). Data were analysed using IBM SPSS Statistics (IBM Corp, Armonk, NY, USA) and MedCalc (MedCalc Software, Ostend, Belgium).

Hand grip strength was recorded using the SH5001 hydraulic dynamometer (Saehan Corporation, Republic of Korea). Walking speed was tested over a path of 2.44 m, and the participants were requested to walk along the path at their usual speed, with assistive devices if required.

Details of the statistical analyses performed are presented in *Box 1*.

### Results

Of the 316 older adults included in this study, 309 had all the variables of interest recorded; of these, 170 (55%) were women and 139 (45%) men. The prevalence of IGS was 22.9% among women and 18.0% among men.

Mean age, anthropometric indicators and motor performance indicators of the studied population are presented in *Table 1*. Among men, BMI, waist circumference, arm circumference and chair stand test times met the inclusion criteria for the multiple logistic regression, while BMI, waist circumference

*“From these results, it can be concluded that waist circumference is predictive of impaired glycaemic state in older men (aged ≥60 years), while BMI is the better predictor in older women.”*

**Table 1. Results of the group comparisons (impaired vs normal glycaemic state) of the candidate variables for inclusion in the multiple logistic regression model. Data presented as means ± standard deviation.**

Variable	Men			Women		
	IGS (n=13)	NGS (n=104)	P value	IGS (n=24)	NGS (n=138)	P value
Age (years)	73.1 ± 9.5	74.9 ± 8.9	0.387	73.8 ± 9.7	75.1 ± 9.8	0.468
BMI (kg/m <sup>2</sup> )	25.2 ± 5.0	23.3 ± 3.8	0.040*	27.1 ± 4.8	24.9 ± 4.8	0.020*
Waist circumference (cm)	95.1 ± 14.4	88.8 ± 15.1	0.068*	98.4 ± 11.1	93.8 ± 12.5	0.047*
Hip circumference (cm)	95.7 ± 9.7	92.1 ± 7.7	0.053*	100.4 ± 9.7	96.8 ± 10.3	0.061*
Waist-to-hip ratio	0.99 ± 0.07	0.95 ± 0.06	0.013*	0.98 ± 0.04	0.97 ± 0.06	0.252
Calf circumference (cm)	34.3 ± 3.8	33.8 ± 3.7	0.516	33.3 ± 3.8	32.5 ± 3.5	0.220
Arm circumference (cm)	28.3 ± 3.9	27.2 ± 3.4	0.130*	29.2 ± 4.3	27.6 ± 4.0	0.038*
Hand grip strength (kg)	29.8 ± 9.3	28.3 ± 10.0	0.482	18.7 ± 5.3	17.9 ± 5.2	0.482
Walking speed test time (s)	3.9 ± 2.5	3.2 ± 1.2	0.055*	4.00 ± 1.4	4.16 ± 2.0	0.675
Chair stand test time (s)	15.2 ± 6.6	13.4 ± 4.8	0.154*	16.6 ± 5.4	16.7 ± 6.8	0.951

\*Variables were included in the multivariable logistic regression analysis as the P value was <0.20. IGS=impaired glycaemic state; NGS=normal glycaemic state.

and arm circumference met the inclusion criteria in women.

Table 2 shows the final predictive model for IGS in older adults according to gender. In the multiple logistic regression model for men, only waist circumference remained, indicating that this variable alone was significantly associated with IGS. In the model for women, only BMI remained.

The discriminatory capacity of the models to identify older adults with IGS was evaluated by receiver operating characteristic (ROC) curve parameters, and the results showed that both models had moderate discriminatory capacity. For men, the area under the curve (AUC) for waist circumference was 0.65 (95% confidence interval [CI], 0.57–0.73), the sensitivity was 45.8 (95% CI, 25.6–67.2) and the specificity was 87.6 (95% CI, 80.1–93.1). The cut-off point was >101 cm.

For women, the (AUC) for BMI was 0.62 (95% CI, 0.54–0.70), the sensitivity was 38.9 (95% CI, 23.2–56.5) and the specificity was 85.0 (95% CI, 77.6–90.7). The cut-off point was >29 kg/m<sup>2</sup>.

**Discussion**

This study aimed to investigate whether anthropometric and motor performance indicators

together could identify and predict IGS in community-dwelling older adults. The results obtained in the multiple logistic regression model showed that, for older men, waist circumference alone had discriminatory and predictive potential for IGS, while only BMI showed this potential for older women.

It is interesting that two different anthropometric indicators were significant in the final model for men and women. This divergence could be explained by differences in body fat distribution between the two genders, as men are usually characterised by android-type fat distribution, with fat accumulation predominantly in the abdominal region (Ley et al, 1992; Blouin et al, 2008), and the amount of fat located inside the abdominal cavity (intra-abdominal or visceral adipose tissue) tends to be twice as high in men as in women (Blouin et al, 2008).

Furthermore, it is known that the relationship between BMI and percentage body fat in men and women diverges during the ageing process, with BMI being a better reflection of body fat composition in older women than in older men (Meeuwssen et al, 2010). This might explain the absence of BMI in the predictive model generated for men.

From a biological point of view, these results could be explained by the fact that free fatty acids deriving from lipolysis may induce insulin resistance (Montague and O’Rahilly, 2000; Ribeiro Filho et al, 2006). Another mechanism could be the secretion of numerous adipokines from adipocytes, which directly influence tissue sensitivity to insulin (Lebovitz and Banerji, 2005; Ribeiro Filho et al, 2006).

It is noteworthy that the final model obtained for both genders presented cut-off points (waist circumference >101 cm for older men and BMI >29 kg/m<sup>2</sup> for older women) with high specificities of around 85%. This makes these factors a good potential screening tool, especially given that they are cheap and easy to measure. The cut-off points obtained here should be considered in future studies as an option to aid in screening for IGS in clinical practice and/or in epidemiological studies involving older adults. These results should only be applied to populations with similar characteristics (e.g. age group and ethnicity), but further studies to determine the generalisability of these findings to other populations are encouraged.

### Conclusion

From these results, it can be concluded that waist circumference is predictive of IGS in older men (aged ≥60 years), while BMI is the better predictor in older women. These two anthropometric measures can be used to screen for this outcome in the community, which could contribute to early identification of IGS risk and enable the adoption of preventive actions and control strategies.

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**Table 2. Regression coefficient, odds ratios and 95% confidence intervals of the variables included in the final prediction model for impaired glycaemic state in older men and women.**

Variable	Regression coefficient	Standard error	Odds ratio	95% confidence interval	P value
<b>Men*</b>					
Waist circumference	0.056	0.020	1.06	1.02–1.10	0.006
Intercept	–6.764				
<b>Women**</b>					
BMI	0.086	0.038	1.09	1.01–1.17	0.025
Intercept	–3.498				

\*Model statistically significant (P=0.001). \*\*Model statistically significant (P=0.02).

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