Estimated average glucose and fasting plasma glucose in outpatient adults from a Tertiary Portuguese Hospital

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Background

Glycated hemoglobin (HbA1c):

- Evaluate the glycemic control in diabetic patients; estimating mean glycemia of the last 120 days;
- Assay methods certified by the National Glycohemoglobin Standardization Program (NGSP) and calibrated to the Diabetes Control and Complications Trial (DCCT) reference.

Several factors may interfere with glucose and HbA1c measurement, affecting accuracy.

AIMS

- 1) To evaluate the association between estimated average glucose (eAG) and fasting plasma glucose (FPG).
- 2) To assess possible interfering factors in that association.

Methods

RETROSPECTIVE STUDY

- Concomitant measurement of hemoglobin (Hb), HbA1c and FPG from outpatient adults followed in Centro Hospitalar São João. Only the last sample of each patient was included in analysis.
- Exclusion criteria: age bellow 18 years old, inpatient care, Day Hospital, pregnant women, Primary Health Care Centre, other specific reasons.

ANALYSED DATA

- Hemoglobin, Hb (g/dL): sodium-lauryl-sulphate method; Sysmex XE-5000 or Sysmex XE-2100 D. Anemia: Hb < 12 g/dL (if female) or 13 g/dL (if male)
- Creatinine, Cr (mg/dL): colorimetric method / Jaffe reaction; Olympus AU5400 - Beckman Coulter. Glomerular filtration rate, GFR (mL/min/1.73 m²): $175 \times (S_{cr})^{-1.154} \times (Age)^{-0.203} \times (0.742 \text{ if female})$
- FPG (mg/dL): enzymatic-ultraviolet assay; Olympus AU5400 - Beckman Coulter
- HbA1c (%): ionic exchange HPLC (High-Performance Liquid Chromatography); Variant II Turbo Bio-Rad. eAG (mg/dL): $28.7 \times HbA1c (\%) - 46.7$

STATISTICAL ANALYSIS (SPSS Statistics 20.0): Frequencies, percentages, mean, standard deviation, Kolmogorov-Smirnov test; Pearson correlation, Fisher r-to-z transformation, independent-samples T test, One-Way ANOVA test, chi-square test, simple and multiple linear regression.

Results

24 380 patients, 55.9% female

Male, patients > 65 years, with anemia and those with stage 3 or 4 CKD had higher HbA1c, eAG and FPG levels (all differences with $p < 0.001$, data not shown).

Table 1: Correlations between FPG and eAG.

		r value	z value	p value
Sex	Female	0.729	6.391	< 0.001
	Male	0.688		
Age	< 65	0.738	11.293	< 0.001
	> 65	0.664		
Anemia	Absent	0.738	13.53	< 0.001
	Present	0.626		

Graph 1: Overall correlation between FPG and eAG.

Table 2: Multivariate analysis model – predictors factors of eAG.

Model	Unstandardized β	Std. Error	95% confidence Interval	Standardized β	t value	p value
(Constant)	65.167	1.871	61.500; 68.834		34.834	< 0.001
FPG (mg/dL)	0.547	0.004	0.540; 0.554	0.697	152.507	< 0.001
Sex (female)	1.053	0.372	0.323; 1.783	0.014	2.827	0.005
Age (years)	0.207	0.012	0.184; 0.231	0.088	17.155	< 0.001
Hb (g/dL)	-0.376	0.109	-0.591; -0.162	-0.018	-3.440	0.001
GFR (mL/min/1.73 m ²)	-0.042	0.005	-0.053; -0.032	-0.041	-7.788	< 0.001

In multivariate analysis model, FPG was a strong predictor of eAG.

For each $\uparrow 1$ mg/dL in FPG $\rightarrow \uparrow 0.697$ mg/dL in eAG (keeping constant the other variables).

FPG, age, sex, Hb and GFR allowed to explain 50% of the eAG variation ($r^2 = 0.519$).

Conclusion

- This is **one of the largest real-life studies** regarding the association between eAG and FPG (to our best knowledge, this is the **first Portuguese** study). Any insights into the glucose measurement that have the effect on HbA1c can help to plan optimal glucose-monitoring regimens.
- We reported an overall **positive correlation between eAG and FPG** ($r=0.711$), stronger in female, younger patients and in those without anemia.
- Although several interfering factors, **FPG was a strong predictor of eAG, even in multivariate analysis**. However, eAG and HbA1c are **difficult to predict using FPG values alone**.

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