

Reference Values For Arterial Blood Gases At An Altitude Of 2640 Meters

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Rationale

There is an inverse relationship between altitude, barometric and oxygen pressures: at higher altitudes lower barometric, inspired and arterial (PaO_2) pressures. This stimulates the respiratory centers to increase alveolar ventilation decreasing PaCO_2 and HCO_3^- . The purpose of this study was to establish normal values for arterial blood gases (ABG) in Bogota, a city located at high altitude: 2640 m.

Methods

Cross sectional study done in healthy non-smoking, non-obese adults, ≥ 18 years, male and female, with a normal spirometry, who were born above 2000 meters and have lived for more than 10 years in Bogota. The presence of acute alveolar hyperventilation during the arterial puncture was ruled out by minute ventilation and respiratory exchange ratio measurements. Analysis of group differences was tested using unpaired t test and ANOVA. The correlations between age, PaO_2 and PaCO_2 were calculated.

Table 1. PaCO_2 , PaO_2 and P(A-a)O_2 by sex and age (N=374)

Age	PaCO_2 , mmHg		PaO_2 , mmHg		P(A-a)O_2 , mmHg	
	Men	Women**	Men**	Women**	Men**	Women**
<30	33,3 2,4*	30,3 2,1	68,1 4,0	70,1 4,6	7,7 3,5	8,5 4,7
30-39	33,4 2,7*	31,4 2,2	66,7 4,5	66,9 4,2	9,6 5,1	11,1 4,2
40-49	33,2 2,8	31,8 3,0	66,4 5,6	66,7 4,8	9,9 5,2	11,1 4,8
50-59	33,3 1,8*	34,3 1,7	65,9 4,0*	62,4 3,8	10,5 4,0*	13,1 3,9
60-69	34,5 2,7	35,3 3,3	64,1 4,4*	59,8 6,1	10,8 4,0*	14,9 5,3
≥ 70	33,3 2,4*	30,3 2,1	62,5 4,9	60,5 4,4	13,6 5,2	15,6 4,0

Values: mean \pm SD. ** $p < 0.01$ differences by age in men and women, * $p < 0.05$ differences between men and women by age.

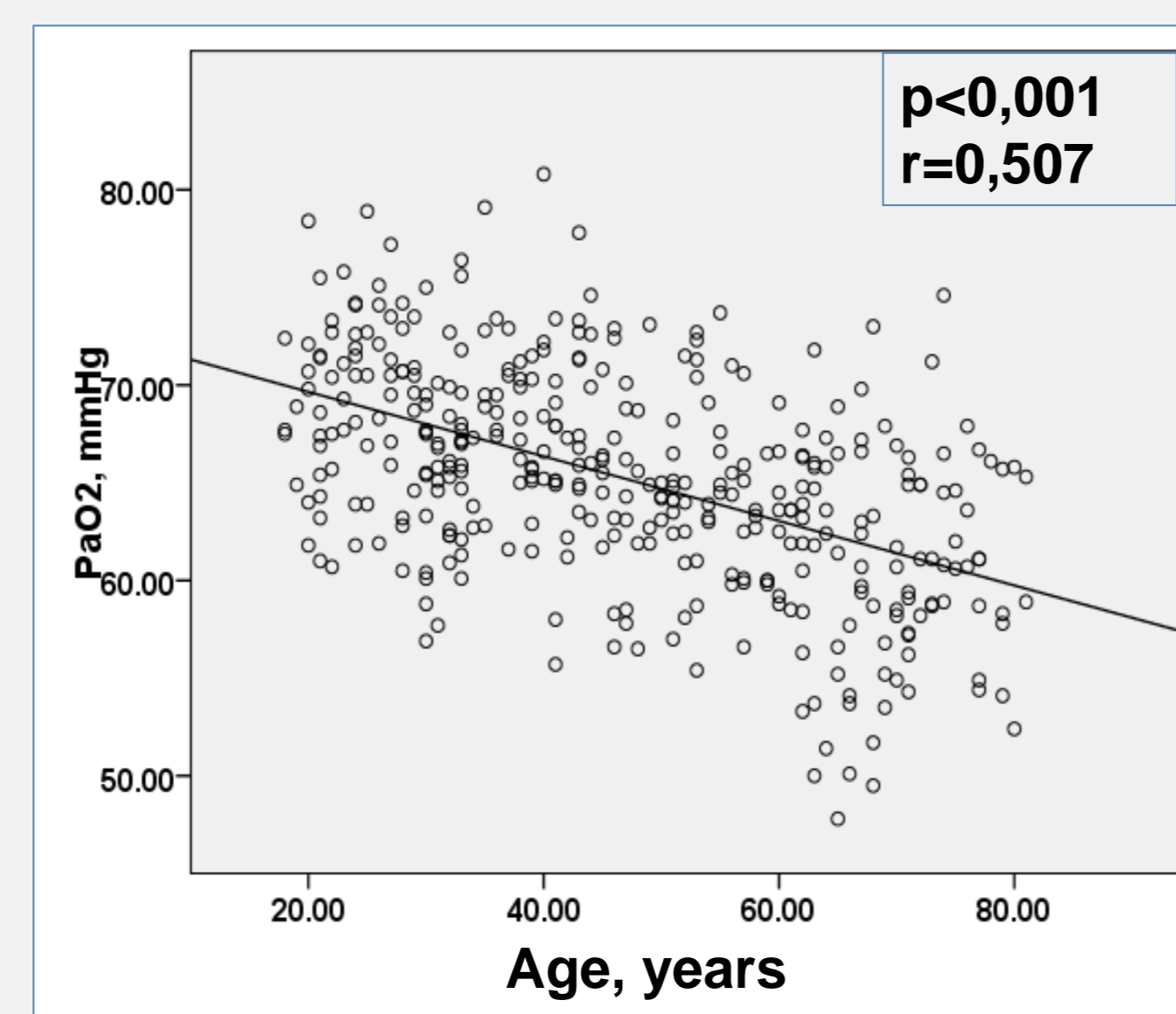


Figure 1. PaO_2 as a function of age

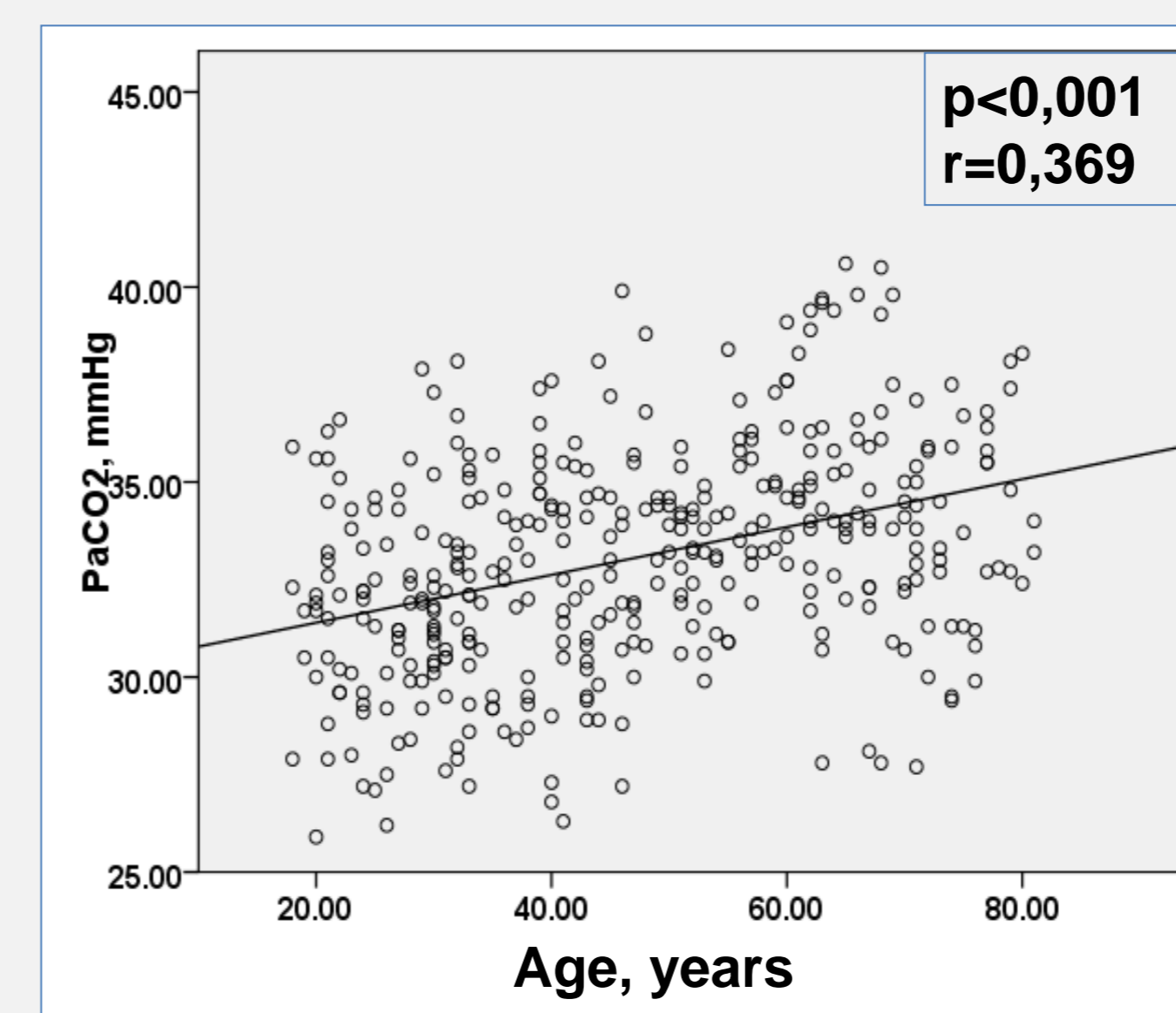


Figure 2. PaCO_2 as a function of age

Results

We included 374 healthy adults, 18 to 83 years old, 55% women. There were no differences by gender or age in the pH (7,43 \pm 0,02). There was a decrease of the PaO_2 and SaO_2 and an increase of the P(A-a)O_2 and PaCO_2 as the age increased ($P < 0.001$) (Table 1). In comparison with males, the PaO_2 was significantly lower in women 50 to 69 years old and the PaCO_2 significantly lower in women 18 to 39 years old. The correlations between the age, the decrease in PaO_2 and the increase in PaCO_2 are shown in the Figures 1,2.

Conclusions

This study of a representative sample of healthy subjects of both genders establishes the reference values for ABG in Bogota, a city located at high altitude (2640 m). As expected, the PaO_2 and PaCO_2 were significantly lower than the normal values at sea level. The PaO_2 decreased and the PaCO_2 increased with age, particularly in women after 50 years old. We postulate that the lower PaCO_2 seen in young women can be explained by higher alveolar ventilation related to hormonal activity which decreases with age.