

## Commentary

# Reference Values of Pulse Wave Velocity in South America: A Call to Action

Alejandro Díaz<sup>1\*</sup>, Agustín J. Ramírez<sup>2,3</sup> and Edmundo Ignacio Cabrera Fischer<sup>2</sup>

<sup>1</sup>School of Health Sciences, National University of the Center of Buenos Aires Province, Argentina

<sup>2</sup>Favaloro University (AIDUF-CONICET), Argentina

<sup>3</sup>Arterial Hypertension and Metabolic Unit, Fundación Favaloro, Argentina

## COMMENTARY

The measurement of pulse wave velocity (PWV) is a well-known technique currently considered the gold standard of arterial stiffness quantification due to its simplicity, accuracy, reproducibility, and predictive value [1]. Recently, the guidelines from the European Society of Hypertension confirmed the PWV as a marker of organ damage having better cardiovascular predictive value, greater reproducibility and acceptable cost-effectiveness relationship [2]. Contemporary guidelines pointed out that values of carotid-femoral PWV > 10 m/s (corrected distance x 0.8) should be considered beyond the physiological range emphasizing the relevance of identifying changes in PWV as a prognostic factor and an early marker of vascular stiffness [2]. However, the lack of appropriate hardware in the clinical setting limits a wide utilization of this technique.

In the last 10 years, substantial data were provided supporting the fact that aortic stiffness, assessed by carotid-femoral PWV, can predict the occurrence of cardiovascular events and mortality even after considering other traditional cardiovascular risk factors. It was shown that an increase of PWV of 1 m/s (according to sex and age) increased 14% cardiovascular events, 15% cardiovascular mortality and 15% of total mortality or that an increase of 1 standard deviation is associated with a 47% increase in cardiovascular events, 47% of cardiovascular mortality and 42% of total mortality. In addition, the predictive value of PWV is greater in young people and not modified by the presence of hypertension, smoking, gender and diabetes or kidney disease [3,4]. Finally, for practical purposes, the increase of 1 standard deviation in the PWV value represent an increase of 10 mmHg in systolic blood pressure and 10 years in arterial aging [3].

However, the available contemporary PWV normal values come mostly from multicenter registries obtained in Asia [5], USA [6,7] and Europe [8,9]. In South America, the reference values used are those derived from a European population, published by the Arterial Stiffness Collaboration Group [9]. The normal values reported, comes from a retrospective analysis of PWV obtained with different methodologies in 13 European centers of high

### \*Corresponding author

Alejandro Díaz, School of Health Sciences, National University of the Center of Buenos Aires Province, 4 de abril 618, Tandil, Buenos Aires, Argentina, Tel: 542-494-221-010; E-mail: alejandrunicen@gmail.com

Submitted: 22 March 2015

Accepted: 31 March 2015

Published: 02 April 2015

### Copyright

© 2015 Díaz et al.

OPEN ACCESS

complexity. Nevertheless, some points merit to be discussed

- -Subjects under 30 years old were included in a single group.
- -Different methods of PWV evaluation were accepted for data collection calling for appropriate comparative studies of these different methodologies.
- -The mentioned reference values of PWV arise from a retrospective analysis of patients, evaluated in different specialized centers, involving considerable selection bias when trying to extrapolate these data to South American epidemiological studies.

Moreover, according to previous investigations, interethnic variations, in genetic composition and established cardiovascular risk factors, are determinants for the differences in the dynamic properties of the arteries [10]. In this way, several studies, in Latin American and Hispanic populations in North America, have shown statistically significant differences in size, structure and arterial stiffness of large and small arteries [11,12]. Nevertheless, in South America, there are very few studies that evaluate arterial stiffness [13,14], meaning that, despite the recognized value of PWV for predicting cardiovascular risk, there are scarce reference values (normal values). The only reference for normal PWV values available until 2012 was in a urban population reported by the Republic of Uruguay [13]. More recently, we have reported PWV reference values, in healthy normotensive people from an urban and rural Argentine population. In this study we include adolescents, young adults and older people from which we reported normal values related to decades of life [14]. In Table 1, we summarized the normality values according to age groups reported by the European population and the two records from South America [13,14]. These studies have several peculiarities in relation to the European Stiffness Collaboration database:

- 1) Farro et al. reported the PWV reference values from 429 subjects selected from a general population in a hospital of Uruguay [13]. The authors used a similar methodology to that used in our group, but patients were divided in only six age categories. Furthermore, subjects older than

**Table 1:** Normal Values of PWV (m/s) according age groups from the Arterial Stiffness Collaboration (Europe) [9], CUiiDARTE Registry [13] and the Argentinean Registry [14].

Age Group (years)	Europe Mean±2 SD	Uruguay Mean±2SD	Argentina Mean±1 SD,CI 95%
10-19	NDA	5.8 (4.7-6.8)	5.0±0.7 (4.9-5.1)
<30	6.2 (4.7-7.6)	6.9 (4.4-9.4)	5.8±0.9(5.6-6.0)
30-39	6.5 (3.8-9.2)	7.7 (6.1-9.2)	6.3±0.8 (6.1-6.4)
40-49	7.2 (4.6-9.8)	7.8 (6-9.7)	6.8±0.9 (6.6-7.0)
50-59	8.3 (4.5-12.1)	8.9 (6.4-11.5)	8.1±1.1 (7.9-8.3)
60-69	10.3 (5.5-15)	NDA	8.4±1.0 (8.2-8.6)
>70	10.9 (5.5-16.3)	NDA	9.0±2 (8.2-9.7)

**Abbreviations:** SD: Standard Deviation; CI: Confidence Interval; NDA: No Data Available.

60 years were include in a single group and the number of subjects included in each group is smaller than those in the European Arterial Stiffness Collaboration group.

- The Argentine study reported by Díaz et al. [14] represents the first record based on urban and rural population that determines normal values of PWV in a large number of healthy normotensive subjects. Additionally, an original and differential aspect was included in the data collection: the absence of first relative degree of arterial hypertension and a statistical comparable number of subjects in each decade of life that covers a wider range of ages (from 10 to 98 years).
- The PWV data reported in Argentina and Uruguay were obtained with a similar technology (synchronous, digitized and automated measurements in the carotid - femoral pathway). This allows to compare data from other populations and to have a more reliable evaluation of therapeutic interventions on vascular dynamics.

In Summary, the definition of PWV normalcy in a population represents an essential step before to consider the incorporation of the arterial stiffness as a useful tool, in clinical practice, for organ damage detection and prognostic index. As age is the main determinant of arterial stiffness across all ethnic populations, the reference values for PWV should be established for each decade of life [10] in the different ethnic populations under study, contributing by this way to facilitate clinical diagnosis, follow-up and therapeutic decisions [10].

Finally, it is important to emphasize the need for epidemiological studies in South America, to provide reliable reference values of arterial stiffness, which still remains a challenge for our region.

## REFERENCES

- Van Bortel LM, Laurent S, Boutouyrie P, Chowienczyk P, Cruickshank JK, De Backer T, et al. Expert consensus document on the measurement of aortic stiffness in daily practice using carotid-femoral pulse wave velocity. *J Hypertens* 2012; 30: 445-448.
- Mancia G, Fagard R, Narkiewicz K, Redon J, Zanchetti A, Bohm M, et al. 2013 ESH/ESC guidelines for the management of arterial hypertension: the Task Force for the Management of Arterial Hypertension of the European Society of Hypertension (ESH) and of the European Society of Cardiology (ESC). *Eur Heart J*. 2013; 34 : 2159-2219.
- Vlachopoulos C, Aznaouridis K, Stefanadis C. Prediction of cardiovascular events and all-cause mortality with arterial stiffness: a systematic review and meta-analysis. *J Am Coll Cardiol*. 2010; 55: 1318-1327.
- Ben-Shlomo Y, Spears M, Boustred C, May M, Anderson SG, Benjamin EJ, et al. Aortic pulse wave velocity improves cardiovascular event prediction: an individual participant meta-analysis of prospective observational data from 17,635 subjects. *J Am Coll Cardiol*. 2014; 63: 636-646.
- Avolio AP, Chen SG, Wang RP, Zhang CL, Li MF, O'Rourke MF. Effects of aging on changing arterial compliance and left ventricular load in a northern Chinese urban community. *Circulation*. 1983; 68: 50-58.
- Mitchell GF, Parise H, Benjamin EJ, Larson MG, Keyes MJ, Vita JA, et al. Changes in arterial stiffness and wave reflection with advancing age in healthy men and women: the Framingham Heart Study. *Hypertension*. 2004; 43: 1239-1245.
- Elias M. Norms and reference values for pulse wave velocity: one size does not fit all. *J Biosci Med* 2011; 1:1-10.
- McEniery CM, Yasmin, Hall IR, Qasem A, Wilkinson IB, Cockcroft JR, et al. Normal vascular aging: differential effects on wave reflection and aortic pulse wave velocity: the Anglo-Cardiff Collaborative Trial (ACCT). *J Am Coll Cardiol*. 2005; 46: 1753-1760.
- The Reference Values for Arterial Stiffness Collaboration. Determinants of pulse wave velocity in healthy people and in the presence of cardiovascular risk factors: 'establishing normal and reference values'. *Eur Heart J*. 2010; 31: 2338-2350.
- Odili AN, Gu Y, Staessen JA. In: Properties of Central Arteries in Populations of Different Ethnicity: Ethnicity and Central Arteries. Safar ME Editors. *Blood Pressure and Arterial Wall Mechanics in Cardiovascular Diseases*. Springer-Verlag London. 2014; 459-464.
- Touboul PJ, Vicaute E, Labreuche J, Acevedo M, Torres V, Ramirez-Martinez J, et al. Common carotid artery intima-media thickness: the Cardiovascular Risk Factor Multiple Evaluation in Latin America (CARMELA) study results. *Cerebrovasc Dis*. 2011; 31: 43-50.
- Chirinos JA, Kips JG, Roman MJ, Medina-Lezama J, Li Y, Woodiwiss AJ, et al. Ethnic differences in arterial wave reflections and normative equations for augmentation index. *Hypertension*. 2011; 57: 1108-1116.
- Farro I, Bia D, Zócalo Y, Torrado J, Farro F, Florio L, et al. Pulse Wave Velocity as Marker of Preclinical Arterial Disease: Reference Levels in a Uruguayan Population Considering Wave Detection Algorithms, Path Lengths, Aging, and Blood Pressure. *Inter J Hypertens*. 2012; 169359.
- Díaz A, Galli C, Tringler M, Ramírez A, Cabrera Fischer EI. Reference values of pulse wave velocity in healthy people from an urban and rural argentinean population. *Int J Hypertens*. 2014; 2014: 653239.

### Cite this article

Díaz A, Ramírez AJ, Cabrera Fischer EI (2015) Reference Values of Pulse Wave Velocity in South America: A Call to Action. *Ann Clin Exp Hypertension* 3(2): 1024.