

Easy conversion of cardio-ankle vascular index into CAVI₀: influence of scale coefficients

Bart Spronck^{a,b}, Michal Mestanik^{c,d},
Ingrid Tonhajzerova^{d,c}, Alexander Jurko^e,
Isabella Tan^f, Mark Butlin^f, and
Alberto P. Avolio^f

In this correspondence, we briefly explain how details on cardio-ankle vascular index (CAVI; [1]) as recently released by Fukuda Denshi [2] can be used to convert CAVI into CAVI₀ [3]. We provide an easy-to-use PDF calculator as well as a Microsoft Excel workbook to facilitate this process (Supplemental digital content 1 and 2, <http://links.lww.com/HJH/B115>, <http://links.lww.com/HJH/B116>).

We have recently investigated the theoretical blood pressure dependence of cardio-ankle vascular index as measured using the VaSera device (Fukuda Denshi Co., Ltd., Tokyo, Japan) and proposed a novel, corrected index: CAVI₀ [3]. Direct conversion between CAVI and CAVI₀ proved difficult, as the CAVI equation contains two proprietary scale coefficients *a* and *b* [1]:

$$\text{CAVI} = a \cdot \underbrace{\left(\ln\left(\frac{P_s}{P_d}\right) \cdot \frac{\text{PWV}^2 \cdot 2\rho}{P_s - P_d} \right)}_{\text{unscaled CAVI}} + b, \quad (1)$$

with PWV the pulse wave velocity from the heart to the left or right ankle (resulting in L-CAVI or R-CAVI, respectively), *P_s* and *P_d* the SBP and DBP as measured by the VaSera device at the right upper arm (regardless of computing L-CAVI or R-CAVI [2,4]), and $\rho = 1050 \frac{\text{kg}}{\text{m}^3}$ the blood mass density [2].

We previously set out to estimate scale coefficients *a* and *b* from measurement data [4]. Such method, however, necessarily has the limitation that *a* and *b* can only be obtained approximately and not exactly. Recently, Fukuda Denshi fully disclosed the values of *a* and *b*, as well as other details on the calculation of CAVI [2] – a step that should be applauded. This disclosure allows for a direct, exact conversion of CAVI into CAVI₀:

$$\text{CAVI}_0 = \frac{\text{CAVI} - b}{a} \cdot \frac{\frac{P_s}{P_d} - 1}{\ln\left(\frac{P_s}{P_d}\right)} - \ln\left(\frac{P_d}{P_{\text{ref}}}\right), \quad (2)$$

with *P_{ref}* = 100 mmHg a reference pressure [3]. The values of *a* and *b* in the CAVI equation are different for different

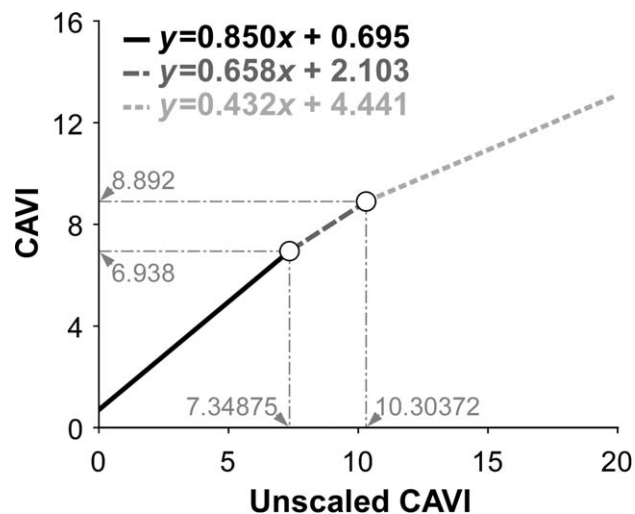


FIGURE 1 Influence of the use of three sets of scale coefficients *a* and *b* [2] on the relationship ($y = ax + b$) between cardio-ankle vascular index (CAVI, *y*) and unscaled CAVI (*x*).

ranges of CAVI [2]. Two cut-off points are implemented, resulting in three sets of values for the coefficients *a* and *b*. Figure 1 visualizes these variable scaling coefficients, as well as the cut-off points in CAVI and unscaled CAVI. This also implies that, when converting CAVI to CAVI₀ (Eq. 2), the values for *a* and *b* should be matched to the measured value of CAVI.

To simplify the CAVI-to-CAVI₀ conversion process, we created an easily fillable Adobe PDF form for conversion of single CAVI measurements (Fig. 2, Supplemental digital content 1, <http://links.lww.com/HJH/B115>) as well as a Microsoft Excel workbook for conversion of larger data sets (Supplemental digital content 2, <http://links.lww.com/HJH/B116>). Note that the PDF form was designed to be opened using Adobe Reader (<http://www.adobe.com/go/getreader>); other PDF readers may not support in-PDF calculations.

The critical reader is pointed to some nomenclature variations: in this correspondence, CAVI as provided by the VaSera device is simply termed CAVI; our previous studies referred to it as CAVI_{VS} [3,4]. Unscaled CAVI (this correspondence) is called *haß* by Takahashi *et al.* [2] and was referred to simply as CAVI in our previous studies [3,4]. Finally, we would like to point out that a researcher with full access to the CAVI (VaSera) source data can also compute CAVI₀ (Eqs. 9 and 10 in [4]) without CAVI as an intermediate step.

In conclusion, we hope that this correspondence and the tools provided will help every user interested in using CAVI₀ – whether clinician, researcher, or engineer – to easily convert CAVI into CAVI₀ values.

Left CAVI 6	Right CAVI 7	P_{ref} [mmHg] 100
P_s [mmHg] 120 P_d [mmHg] 80		Enter right brachial systolic and diastolic blood pressures reported by the VaSera device here
Left		Right
a 0.850	a 0.658	
b 0.695	b 2.103	
Unscaled CAVI 6.24	Unscaled CAVI 7.44	
Left $CAVI_0$ 7.92	Right $CAVI_0$ 9.40	

FIGURE 2 Screenshot of Adobe PDF CAVI-to- $CAVI_0$ conversion tool with a completed CAVI-to- $CAVI_0$ conversion (Supplemental digital content 1, <http://links.lww.com/HJH/B115>). The user enters CAVI and SBP and DBP values (P_s and P_d) in the light boxes, after which the form automatically determines the appropriate scale coefficients (a and b), determines unscaled CAVIs, and converts those to $CAVI_0$ s. CAVI, cardio-ankle vascular index; $CAVI_0$, cardio-ankle vascular index zero [3]; P_{ref} , reference pressure [3].

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Conflicts of interest

There are no conflicts of interest.

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^aDepartment of Biomedical Engineering, Yale University, New Haven, Connecticut, USA, ^bDepartment of Biomedical Engineering, CARIM School for Cardiovascular Diseases, Maastricht University, Maastricht, the Netherlands, ^cBiomedical Center Martin, ^dDepartment of Physiology, Jessenius Faculty of Medicine in Martin, Comenius University in Bratislava, ^ePediatric Cardiology, Martin, Slovak Republic and ^fDepartment of Biomedical Sciences, Faculty of Medicine and Health Sciences, Macquarie University, Sydney, NSW, Australia

Correspondence to Bart Sponck, PhD, Department of Biomedical Engineering, Yale University, 55 Prospect Street, New Haven, CT 06511, USA. Tel: +1 203 432 6678; e-mail: bart.spronck@yale.edu

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