他装置との臨床での比較調査

文献	機器	患者数	項目	結果
Fakhrawi D.H. – 2009	(RJL) Sciences Quantum II	33	Bioelectrical impedance	The purpose of this study was to compare the Rudolph J. Liedtke (RJL) Sciences Quantum II system bioelectrical impedance analyzer (BIA) with the fan beam Hologic dual-energy X-ray absorptiometry (DXA, software V8.26a) for assessing body composition in postmenopausal obese women. Thirty-three postmenopausal overweight/obese females (mean age: 53.9+/-6.0 yr; mean weight: 91.3+/-17.5 kg; and mean body mass index [BMI]: 33.1+/-5.7 kg/m2) were evaluated for comparison of body weight (BW), fat mass (FM), percent FM (%FM), and fat free mass (FFM). The comparison was assessed by RJL Quantum 2 Cyprus 2.6 (Clinton Township, MI) BIA vs fan beam DXA Hologic QDR-4500A software V8.26a (ODR 4500 Hologic, Inc., Waltham, Mass). RJLBIA and DXA measurements were performed at the same time. BW was measured using a balance scale (Detecto; Web City, MO) and these results were used for the RJL-BIA analysis. Balance weight was compared with DXA BW. Correlations between DXA and RJL-BIA for BW, FM, %FM, and FFM were 0.998, 0.980, 0.782, and 0.926 ($p<0.01$), respectively. Bland- Altman plots demonstrated general agreement between methods for BW, FM, %FM, and FFM. However, for the latter 3 metrics of body composition, one unit change using BIA does not correspond to one unit change using DXA, as there were systematic disagreements at either end of the range of values. But RJL-BIA could be a valid method for assessing body composition of overweight/obese postmenopausal women once appropriate validated regression equations have been developed. Purposes were to (a) to examine the validity and precision of a hand-tohand bioelectrical impedance analyzer (HBIA) and (b) to determine the effect of an acute sub-maximal aerobic exercise bout on HBIA percent body fat (%BF) measures. Forty-one young adults (21 women; 20 men) visited the laboratory for body composition assessment on two separate occasions. During the control session, %BF was assessed by HBIA twice, before and immediately after 30 min of rest, and once by air-displacement plethysmography (ADP), using the BOD POD, which was considered the criterion method for comparison. During the exercise session, HBIA %BF measurements were determined prior-to and immediately after 30 minutes of moderate-intensity treadmill exercise.

文献	機器	患者数	項目	結果
				HBIA significantly underestimated %BF in the total sample (mean difference (MD) = 1.4 ± 4.3%) and, when examined by gender, in the women (MD = 2.4 ± 4.1%). The standard errors of estimate (range 4.1– 4.3%) also exceeded the recommended range for accuracy (<3.5%). Following exercise, there was minimal, but statistically significant reduction in HBIAmeasured %BF pre– to post–exercise for the total sample (19.6 ± 6.0 vs. 19.3 ± 6.0%; p = 0.011). HBIA underestimated %BF when compared to ADP and the individual prediction error exceeded current recommendations when assessing young adults. In addition, performing submaximal aerobic exercise prior to the assessment decreased the %BF estimate. When one factors the exercise–induced alterations with the currently observed tendency for HBIA to underestimate %BF, it is apparent that exercise may further reduce the accuracy of this method.
Weaver A.M. – 2009	HBIA	41	Bioelectrical impedance	Purposes were to (a) to examine the validity and precision of a hand–tohand bioelectrical impedance analyzer (HBIA) and (b) to determine the effect of an acute sub–maximal aerobic exercise bout on HBIA percent body fat (%BF) measures. Forty–one young adults (21 women; 20 men) visited the laboratory for body composition assessment on two separate occasions. During the control session, %BF was assessed by HBIA twice, before and immediately after 30 min of rest, and once by air–displacement plethysmography (ADP), using the BOD POD, which was considered the criterion method for comparison. During the exercise session, HBIA %BF measurements were determined prior–to and immediately after 30 minutes of moderate–intensity treadmill exercise. HBIA significantly underestimated %BF in the total sample (mean difference (MD) = 1.4 ± 4.3%) and, when examined by gender, in the women (MD = 2.4 ± 4.1%). The standard errors of estimate (range 4.1– 4.3%) also exceeded the recommended range for accuracy (<3.5%). Following exercise, there was minimal, but statistically significant reduction in HBIA measured %BF pre– to post–exercise for the total sample (19.6 ± 6.0 vs. 19.3 ± 6.0%; p = 0.011). HBIA underestimated %BF when compared to ADP and the individual prediction error exceeded current recommendations when assessing young adults. In addition, performing submaximal aerobic exercise prior to the assessment decreased the %BF estimate. When one factors the exercise–

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				induced alterations with the currently observed tendency for HBIA to underestimate %BF, it is apparent that exercise may further reduce the accuracy of this method.
Unick J.L. – 2006	Tanita 300WA	77	Bioelectrical impedance	The current investigation was conducted to evaluate the accuracy of the Tanita 300WA leg–to–leg (LL) bioelectrical impedance analyzer (BIA) for measuring body composition in an American high–schoolaged population. Body composition was determined in 77 students, comparing BIA measurements with the criterion, hydrostatic weighing (HW). Among the males, there were no significant differences found in percent body fat (%BF) between BIA (14.1 +/– 7.8%) and HW (14.9 +/– 9.1%); however, skinfolds (SK; 11.8 +/– 7.2%) were significantly different from HW. A significant correlation in fat free mass (FFM) was found between BIA and HW ($r = 0.96$, $p < 0.001$), and the standard error of estimate (SEE) for FFM was 3.28 kg for males. In females, a significant difference ($p < 0.001$) in %BF was found for both BIA (26.4 +/– 5.7%) and SK (27.9 +/– 5.1%) when compared with HW (23.6 +/– 5.9%). The correlation in FFM between BIA and HW was lower ($r = 0.78$, $p < 0.001$) and the SEE for FFM was 2.93 kg for females. The Tanita 300WA LL–BIA system is appropriate for assessing body composition in male adolescents, but it warrants future research in female adolescents.
Gandhi P.G. – 2014	TM–OXi, Sudopath	65	Galvanic skin response	The spectral analysis of the photoplethysmography method is noninvasive, fast, operator–independent, and cost–effective, as only an oximeter and galvanic skin response device are required in order to assess in a single testing the autonomic nervous system and endothelial function. The spectral analysis techniques used on the photoplethysmogram, as outlined in this study, could be useful when used alongside conventional known cardiovascular disease risk markers. Each spectral analysis PTG marker yielded a high specificity and sensitivity to detect CAD. Most notably, the PTG CVD score had a sensitivity of 82.5% and specificity of 96.8%, at a cutoff of 2, when used to detect CAD ($P=0.0001$; area under the receiver operating characteristic curve $=0.967$). The PTG spectral analysis markers were well–correlated to other autonomic nervous system and endothelial function markers. CAD diabetic patients ($n=27$) had a lower PTGi value compared with the CAD non–diabetic patients ($n=38$): and patients that underwent CABG ($n=18$) had a higher PTGi value compared with the CAD without CABG surgery patients ($n=47$).

文献	機器	患者数	項目	結果
Maarek A. – 2012	EIS device	multiple studies	Galvanic skin response	For each of the EIS clinical results, various explanations were posited, such as: (1) electrical stimulation of the postsympathetic cholinergic fiberactivating NO production in the endothelial cell, which causes vasodilation and a released sweat response (diabetes detection); (2) estimation of interstitial fluid's acid–base balance, which is reflected in an electrochemical reaction on the bulk of the electrodes through the released sweat (prostate cancer detection); (3) estimation of cerebral interstitial fluid chloride ions (detection of ADHD in children); and (4) estimation of the morphology of the interstitial fluid (selective serotonin reuptake inhibitor treatment response).
Zeng Q. – 2014	EZSCAN	5532	Sudomotor function	The EZSCAN results were associated with arterial stiffness independent of conventional factors, blood glucose levels, and glucose tolerance status, suggesting a probable link between the EZSCAN value and arterial stiffness through autonomic dysfunction. The EZSCAN test may help us detect the development of arterial stiffness in high risk individuals to prevent unfavorable cardiovascular events.
Sun J. – 2014	EZSCAN	5076	Sudomotor function	A higher EZSCAN value (≥50), an index of high autonomic dysfunction risk, was associated with an increased risk of elevated ba–PWV and CIMT. Such associations were partially explained by traditional atherosclerotic risk factors. The prevalence of elevated CIMT and ba–PWV increased markedly with increasing EZSCAN values (elevated CIMT 7.4%, 17.5%, and 29.7%, elevated ba–PWV 3.2%, 19.7%, and 36.5%, in Groups 1, 2, and 3, respectively; both Ptrend < 0.0001). Logistic regressions revealed that EZSCAN values ≥50 were associated with a nonsignificantly higher risk of elevated CIMT (odds ratio [OR] = 1.43; 95% confidence interval [CI] 0.98–2.07) and a significantly higher risk of elevated ba–PWV (OR = 2.16; 95% CI 1.25–3.71) compared with EZSCAN values <25, after controlling for conventional risk factors.
Gin H. – 2011	Sudoscan	142	Sudomotor function	Sudoscan™ is a reproducible technique with results that are not influenced by blood glucose levels. Sweating status may be a quantitative indicator of the severity of polyneuropathy that may be useful for the early prevention of foot skin lesions. ESC measurements in the feet of patients showed a descending trend from 66±17 μS to 43±39 μS, corresponding to an ascending trend in VPT threshold from <15 V to >25 V (P=0.001). Correlation between VPT and ESC was −0.45 (P<0.0001). Foot ESC was lower in patients with fissures, while VPT was comparable. Both VPT

文献	機器	患者数	項目	結果
				and foot ESC correlated with retinopathy status. Bland–Altman plots indicated good reproducibility between two measurements, and between low and high glycaemia levels.
Mayaudon H. – 2010	EZSCAN	174	Sudomotor function	The good sensitivity, specificity and reproducibility of EZSCAN make it a feasible alternative for assessing sudomotor dysfunction, a clinical manifestation of autonomic neuropathy in diabetic patients. The test takes<3 min to perform, and requires neither special patient preparation nor medical personnel training. The ESC of hands and feet was significantly reduced in diabetic patients (53±16 μSi and 67±14 μSi, respectively) compared with control subjects (68±16 μSi and 80±7 μSi, respectively; P<0.0001). ESC values had a sensitivity of 75% and specificity of 100%, with an area under the ROC curve of 0.88 at a threshold of 50% on the EZSCAN scale. Coefficients of variation in hand and foot measurements were 15 and 7%, respectively.
Takahashi N. – 2017	ECG	22	Heart rate variability	High frequency and low frequency components were log-transformed based on their distributions. Correlation coefficients between five-minute data and shorter recordings in the supine position with natural breathing ranged from 0.80 to 0.91 (HF by 10-second recording, 0.80; LF by 30-second recording, 0.83, respectively). Bland-Altman plots showed that gaps between the values from both methods slightly increased as the HF and LF component values increased. Although slight proportional errors were possible, values from standard five-minute and shorter recordings in the supine position were strongly correlated. Our findings suggest that shorter ECG data without strict preconditioning can be reliably used for spectral analysis. This article is protected by copyright. All rights reserved.
Plews D.J. – 2017	Smartphone PPG and ECG	29	Heart rate variability	Both PPG and heart rate sensor provide an acceptable agreement for the measurement of rMSSD when compared with ECG. Smartphone PPG technology may be a preferred method of HRV data collection for athletes due to its practicality and ease of use in the field. Compared to ECG, the technical error of estimate (TEE) was acceptable for all conditions (average TEE CV% (90% CI) = 6.35 (5.13; 8.5)). When assessed as a standardised difference, all differences were deemed ″Trivial″ (average std. diff (90% CI) = 0.10 (0.08; 0.13). Both PPG and HR sensor derived measures had almost perfect correlations with ECG (R = 1.00 (0.99; 1:00).
Perrotta A.S.	Kubios HRV 2.2	athletes and	Heart rate	The introduction of smartphone applications has allowed athletes and practitioners to record and

文献	機器	患者数	項目	結果
– 2017	Software	practitioners	variability	store R–R intervals on smartphones for immediate heart rate variability (HRV) analysis. This user–friendly option should be validated in the effort to provide practitioners confidence when monitoring their athletes before implementing such equipment. The objective of this investigation was to examine the relationship and validity between a vagal–related HRV index, rMSSD, when derived from a smartphone application accessible with most operating systems against a frequently used computer software program, Kubios HRV 2.2. R–R intervals were recorded immediately upon awakening over 14 consecutive days using the Elite HRV smartphone application. R–R recordings were then exported into Kubios HRV 2.2 for analysis. The relationship and levels of agreement between rMSSDln derived from Elite HRV and Kubios HRV 2.2 was examined using a Pearson productmoment correlation and a Bland–Altman Plot. An extremely large relationship was identified ($r = 0.92$; $p < 0.0001$; confidence interval [CI] 95% = 0.90–0.93). A total of 6.4% of the residuals fell outside the 1.96 ± SD (CI 95% = −12.0 to 7.0%) limits of agreement. A negative bias was observed (mean: −2.7%; CI 95% = −3.10 to −2.30%), whose CI 95% failed to fall within the line of equality. Our observations demonstrated differences between the two sources of HRV analysis. However, further research is warranted, as this smartphone HRV application may offer a reliable platform when assessing parasympathetic modulation.
Giles D. – 2016	Polar V800 heart rate monitor and ECG	20	Heart rate variability	The V800 improves over previous Polar models, with narrower LoA, stronger ICC and smaller ES for both the RR intervals and HRV parameters. The findings support the validity of the Polar V800 and its ability to produce RR interval recordings consistent with an ECG. In addition, HRV parameters derived from these recordings are also highly comparable. A small number of errors were detected between ECG and Polar RR signal, with a combined error rate of 0.086 %. The RR intervals from ECG to V800 were significantly different, but with small ES for both supine corrected and standing corrected data (ES <0.001). The bias (LoA) were 0.06 (−4.33 to 4.45 ms) and 0.59 (−1.70 to 2.87 ms) for supine and standing intervals, respectively. The ICC was >0.999 for both supine and standing corrected intervals. When analysed with the same HRV software no significant differences were observed in any HRV parameters, for either supine or standing; the data displayed small bias and tight LoA, strong ICC (>0.99) and small ES (≤0.029).

文献	機器	患者数	項目	結果
Munoz M.L. – 2015	ECG	3.387	Heart rate variability	Our results confirm that it is unnecessary to use recordings longer than 120s to obtain accurate measures of RMSSD and SDNN in the time domain. Even a single 10s (standard ECG) recording yields a valid RMSSD measurement, although an average over multiple 10s ECGs is preferable. For SDNN we would recommend either 30s or multiple 10s ECGs. Future research projects using time-domain HRV parameters, e.g. genetic epidemiological studies, could calculate HRV from (ultra-)short ECGs enabling such projects to be performed at a large scale.
Flatt A.A. – 2013	The ithlete™ heart rate variability smart phone application with an electrocardiograph	25	Heart rate variability	The purpose of this investigation was to cross-validate the ithlete™ heart rate variability smart phone application with an electrocardiograph for determining ultrashort-term root mean square of successive R-R intervals. The root mean square of successive R-R intervals was simultaneously determined via electrocardiograph and ithlete™ at rest in twenty five healthy participants. There were no significant differences between the electrocardiograph and ithlete™ derived root mean square of successive RR interval values ($p > 0.05$) and the correlation was near perfect ($r = 0.99$, $p < 0.001$). In addition, the ithlete™ revealed a Standard Error of the Estimate of 1.47 and Bland Altman plot showed that the limits of agreement ranged from 2.57 below to 2.63 above the constant error of 0.03. In conclusion, the ithlete™ appeared to provide a suitably accurate measure of root mean square of successive R-R intervals when compared to the electrocardiograph measures obtained in the laboratory within the current sample of healthy adult participants. The current study lays groundwork for future research determining the efficacy of ithlete™ for reflecting athletic training status over a chronic conditioning period.
Hibbert A.S. – 2012	QRSTool and CMetX software	63	Heart rate variability	In the present study, the authors examined the field validity of these software tools – that is, their validity when used by nonexperts. In a lab with extensive expertise in psychopathology but not psychophysiology, ECG data were obtained from 63 undergraduates at baseline and during a stressor and then processed using QRSTool and CMetX to produce the 10 HRV indices described in Allen et al. (2007). The indices displayed factor structures and patterns of changes from baseline to stressor that were similar to findings from field validity of QRSTool and CMetX, suggesting that they are useful for nonexperts in psychophysiology interested in measuring HRV.
McMullen	Heart rate	22	Heart rate	This study investigated with the same recordings whether heart period oscillations or spectral

文献	機器	患者数	項目	結果
M.K. - 2012	variability software		variability	heart rate variability measures could function as estimators of breathing frequency. Continuous 270s cardiovascular recordings were obtained from 22 healthy adult volunteers in the supine and upright postures. Breathing was recorded simultaneously. Breathing frequency and heart period oscillation frequency were calculated manually, while heart rate variability spectral maximums were obtained using heart rate variability software. These estimates were compared to the breathing frequency using the Bland-Altman agreement procedure. Estimates were required to be < ±10% (95% levels of agreement). The 95% levels of agreement measures for the heart period oscillation frequency (supine: -27.7 to 52.0%, upright: -37.8 to 45.9%) and the heart rate variability spectral maximum estimates (supine: -48.7 to 26.5% and -56.4 to 62.7%, upright: -37.8 to 39.3%) exceeded 10%. Multiple heart period oscillations were observed to occur during breathing cycles. Both respiratory and nonrespiratory sinus arrhythmia was observed amongst healthy adults. This observation at least partly explains why heart period parameters and heart rate variability parameters are not reliable estimators of breathing frequency. In determining the validity of spectral heart rate variability measurements we suggest that it is the position of the spectral peaks and not the breathing frequency that should be the basis of decision making.
Smolander J. - 2011	Firstbeat PRO heartbeat analysis software	19	Heart rate variability	This study examined the validity of a new HR - and HR variability-based method (Firstbeat PRO heartbeat analysis software) in the estimation of VO(2) in real-life tasks. The method takes into account the respiration rate determined from HR variability and the differences in the on/off dynamics of HR and VO(2) , and no calibration tests are needed. Ten men and nine women performed 25 tasks representing different types of daily activities. Portable devices were used to measure R-to-R intervals (ECG), VO(2) and respiration rate. In pooled regression analysis, the estimated VO(2) accounted for 87% of the variability in the actual VO(2) , SEE 3·5 ml min(-1) kg(-1) (1 MET). At group level, the method underestimated slightly the measured VO(2) (mean difference - 1·5 ml min(-1) kg(-1) or - 0·4 METs). Some of the values at low exercise intensities were markedly underestimated, but the agreement was better during light and heavy activities. The limits of agreement for the data were from -8·4 to 5·4 ml min(-1) kg(-1) or from -2·4 to 1·5 METs. At individual level, the average deviations of the predicted VO(2) ranged from -1·0 to 0·6 METs and

文献	機器	患者数	項目	結果
				R(2) from 0·77 to 0·94, respectively. The present data indicate that the prediction method may be considered sufficiently accurate to determine the average VO(2) in field use, but it does not allow precise estimation of VO(2) .
Nunan D. – 2009	Polar S810 heartrate monitor	33	Heart rate variability	There were marginal differences between the Polar and the CP mean measures of HRV, and the uncertainty in the differences was small. The Polar S810 demonstrated high correlations (0.85–0.99) with CP for all measures of HRV indicating good to nearperfect validity. Except for the low- and the high-frequency normalized units, Polar S810 did not add any substantial technical error to the within-subject variability in the repeated measurements of HRV. HRV measures obtained with the Polar S810 and accompanying software have no appreciable bias or additional random error in comparison with criterion measures, but the measures are inherently unreliable over a 1-wk interval. Reliability of HRV from longer (e.g., 10 min) and/or consecutive 5-min RR recordings needs to be investigated with the Polar and criterion instruments.
Sluiter J.K. – 2009	HRV measurements	27	Heart rate variability	There was good reproducibility of HRV and RR in participants with prolonged fatigue complaints. Concurrent validity between HRV and RR measurements and fatigue was low. Intra-class orrelation coefficients (ICCs) means for SDNN and RMSSD during reclining and cycling ranged from 0.86 to 0.93. For RR the ICC means were 0.65 and 0.85 for reclining and cycling, respectively. The SEM values (ms) for SDNN and RMSSD ranged from 1.08 to 7.71 while the SEM values for RR were 1.82 and 1.99 for reclining and cycling, respectively. The Pearson correlations were non-significant and ranged from − 0.05 to 0.15.
Gamelin F.X. – 2006	Polar S810 heart rate monitor	18	Heart rate variability	R-R intervals were significantly different in the supine and standing position between the ECG and the HRM uncorrected and corrected signal ($P < 0.05$, ES = 0.000 and 0.006, respectively). The bias +/− LoA, however, were 0.9 +/− 12 ms. HRV parameters derived from both signals in both positions were not different ($P > 0.05$) and well correlated ($r > 0.97$, $P < 0.05$), except root mean square of difference (RMSSD) and SD1 in standing position ($P < 0.05$, ES = 0.052 and 0.057; $r = 0.99$ and 0.98, respectively). Narrow LoA, good correlations, and small effect sizes support the validity of the Polar S810 HRM to measure R-R intervals and make the subsequent HRV analysis in supine position. Caution must be taken in standing position for the parameters sensitive to the short-term

文献	機器	患者数	項目	結果
				variability (i.e., RMSSD and SD1).
von Wowern E. – 2015	Meridian DPA	112	Digital volume pulse	112 pregnant and non-pregnant individuals of different ages and genders were examined with SphygmoCor arterial wall tonometry and Meridian DPA finger photoplethysmography. Coefficients of repeatability, Bland-Altman plots, intraclass correlation coefficients and correlations to heart rate (HR) and body height were calculated for DPA variables, and the DPA variables were compared to tonometry variables left ventricular ejection time (LVET), PWV and AIX. No DPA variable showed any systematic measurementerror or excellent repeatability, but dicrotic index (DI), dicrotic dilatation index (DDI), cardiac ejection elasticity index (EEI), aging index (AI) and second derivatives of the crude pulse wave curve, b/a and e/a, showed good repeatability. Overall, the correlations to AIX were better than to PWV, with correlations coefficients >0.70 for EEI, AI and b/a. Considering the level of repeatability and the correlations to tonometry, the overall best DPA parameters were EEI, AI and b/a. The two pansystolic time parameters, ejection time compensated (ETc) by DPA and LVET by tonometry, showed a significant but weak correlation. For estimation of the LV function, ETc, EEI and b/a are suitable, for large artery stiffness EEI, and for small arteries DI and DDI. The only global parameter, AI, showed a high repeatability and the overall best correlations with AIX and PWV.
Gunarathne A. – 2008	PCA 2; Micro Medical	247	Digital volume pulse	Noninvasive measurements of arterial stiffness may aid the optimal stratification of CVD risk in an apparently healthy population. Of our cohort of 247 individuals (51% male; mean age 55.2 (s.d. 10.3) years), 187 were apparently healthy and 60 had established CVD risk factors (diabetes mellitus: 33%, hypertension: 77.8%, hypercholesteremia: 61%). On univariate analysis, SI was strongly associated with CVD risk (the European Society of Cardiology (ESC) based HeartScore) (Pearson correlation coefficient (R): 0.56, P < or = 0.001) and increased in an ordinal fashion from ″low risk″ to ″medium risk″ to ″high risk″ to ″very high risk″ (pseudo R2 = 0.30; P < 0.001). In receiver operator characteristic curve analysis, SI was the best discriminator between low to medium risk and high-risk categories (area under curve (AUC): 0.76 (95% CI 0.64-0.88), P < 0.001) when compared to total cholesterol, plasma glucose, systolic blood pressure, and waist-to-hip ratio and had the utility to discriminate the individuals with known CVD risk factors such as diabetes and

文献	機器	患者数	項目	結果
				hypertension.
Chen J.Y. – 2005	Photoplethysmograph	124	Digital volume pulse	SIDVP, stiffness index (SI) and distensibility (DI) were significantly correlated with target organ damage in untreated hypertension. However, only the An An index of large artery stiffness (SIDVP) was independently associated with presence of vascular diseases. SIDVP simply derived from the DVP can be used as a marker for risk stratification in untreated hypertensive patients. The SIDVP was significantly correlated with blood urea nitrogen (BUN), and left ventricular mass index (LVMI). Patients with vascular diseases had higher level of SIDVP (10.12+/−2.97 vs 8.45+/− 1.78, p<0.001), SI (13.76+/−7.63 vs 10.87+/− 8.88, p=0.116), BUN (28.4+/−24.7 vs 14.5+/−4.6, p<0.001) and lower level of DI (1.34+/−0.88 vs 1.93+/−1.12, p=0.010) than those without vascular diseases. By multivariate analysis, only the SIDVP was significantly associated with vascular diseases (OR 1.39, 95% CI 1.06–1.82, p=0.016).