Gefäßsteifigkeit

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Abbreviations

- central arterial stiffness: CAS

- pulse wave velocity: PWV

- augmentation index corrected for heart rate at a heart rate of 75 bpm: AIx@75

Introduction (Sebastian)

In addition to depicting a hallmark of ageing, increasing central arterial stiffness (CAS) referring to reduced distensibility and buffering capacity of arteries against pulsatile cardiac load (Avolio, 2013 -> Haapala, 2018) is closely related to cardiovascular morbidity and mortality (Shirwany, 2010). Since exercise was shown to attenuate various cardiovascular risk factors (Nocon, 2008 -> s. Ashor, 2014), different studies have investigated the effects of physical activity on CAS exhibiting equivocal results. A current meta-analysis indicates that the effects of physical activity on CAS strongly depend on exercise mode, i. e. strength- or endurance-type (Sardelli, 2018). Therefore, the aim of the present investigation was to compare 24 sport students of both sexes and various athletic backgrounds in regard to two simply assessable, non-invasive measures of CAS.

Methods (Caro)

Participants:

This study was performed by 24 non-smoking, normotensive, healthy athletes (mean +/- standard deviation, age: 25.5 +/- 2.6 (range: 22-32) years, height: 174.6 +/- 6.3 cm, weight: 72.6 +/- 11.5 kg; 14 male, 10 female).

Study design:

The subjects were tested in a seated position with a cuff placed on their right upper arm. The oscillometric pulse wave analysis (, an indirect method with good agreement with invasive measurements (Horvath, 2010),) was performed at rest by using a Mobil-O-Graph. (Next to automatically measured parameters including systolic and diastolic blood pressure, heart rate, and pulse pressure,–> weglassen, wenn zu viel –> stattdessen:)

Cardiovascular parameters including pulse wave velocity (PWV) and augmentation index (AIx) were analyzed as measures of CAS. AIx was calculated as the increment in pressure from the first shoulder of aortic waveform to the peak of the wave (P_{Aug}), expressed as a percentage of the pulse pressure (PP) shown in the formula $AIx\ (\%) = \left[\frac{(P_{Aug})}{PP}\right] \cdot 100$ and corrected for heart rate of 75 bpm (AIx@75) (see Figure 1) . PWV was computed from the time difference between the first shoulder (t_1) and the peak of the wave (t_2) and was related to the distance between jugulum and symphysis shown in the formula $PWV\ \left(\frac{m}{s}\right) = \frac{Jug - Sy}{\frac{(t_2 - t_1)}{2}}$. (-> wir könnten auch beide Formeln untereinander schreiben, dann nummerieren und im Text darauf verweisen)

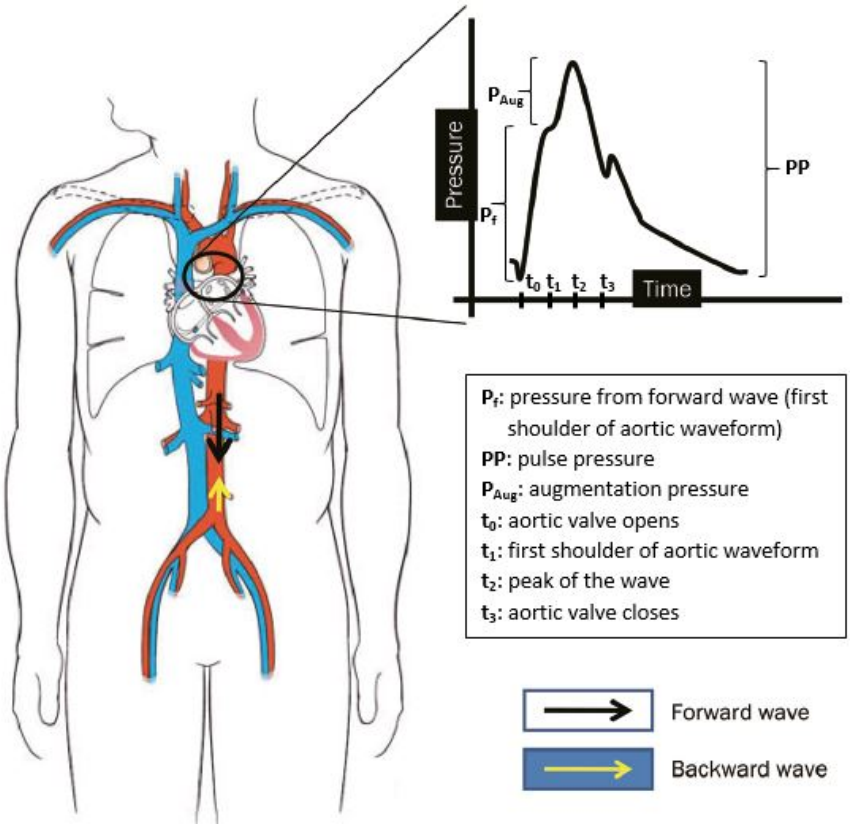

Figure 1: The pressure waveform at the aortic root and its key components. Concept of the forward and backward propagated wave. (modified from Shirwany, 2010)

Statistical Analyses:

The data was sent via Bluetooth to the HMS CS Software for further evaluation. Differences in PWV and AIx% were compared between sexes and exercise type.

Results (Peter)

- Sportarten: Ausdauerathleten mit signifikant niedrigerer PWV -> AIx@75 kein Unterschied

- Geschlechter: Frauen mit signifikant höherem AIx@75 vs. Männer mit fast signifikant ($p<0.06$) höherer

PWV

- keine Korrelation zwischen AIx@75 und PWV (AIx@75 korreliert positiv mit Größe & negativ mit peripherem Widerstand vs. PWV nicht)

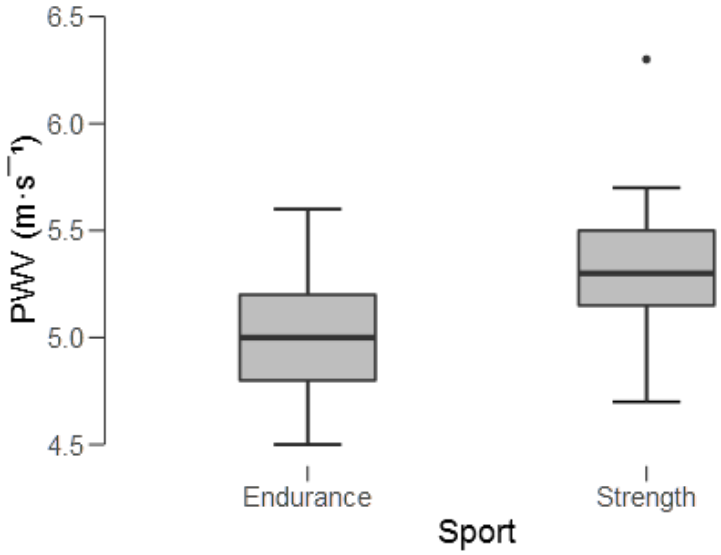

Figure 2: Differences in PWV between exercise and strength trained subjects.

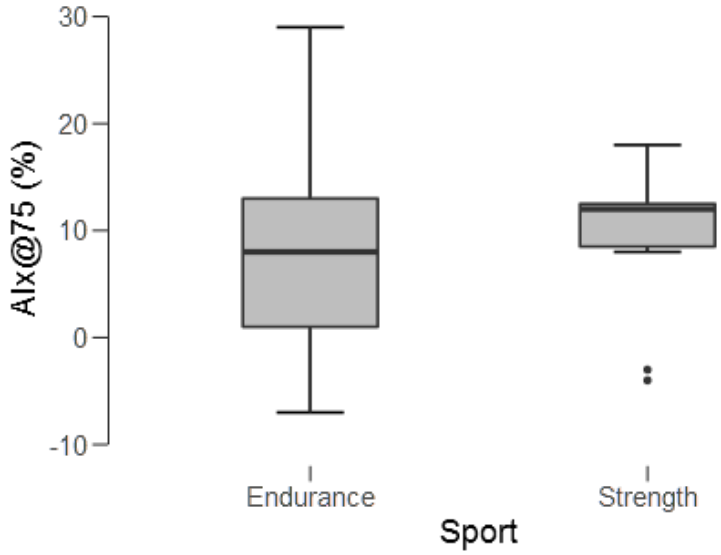

Figure 3: Differences in AIx@75 between exercise and strength trained subjects.

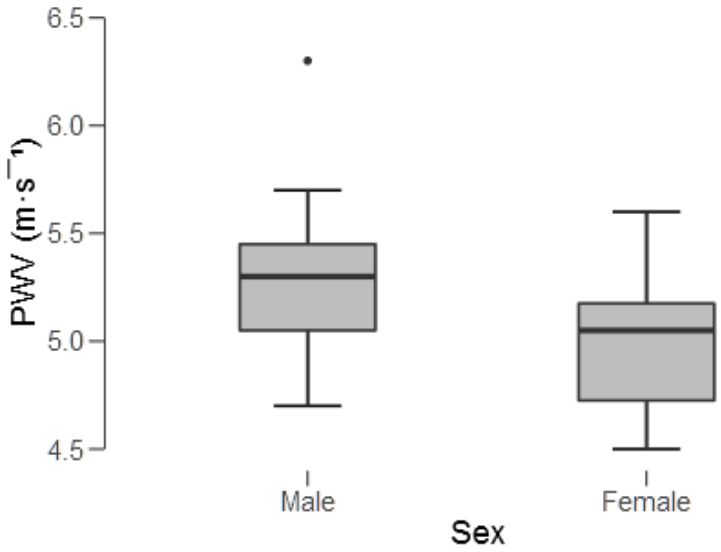

Figure 4: Differences in PWV between male and female students.

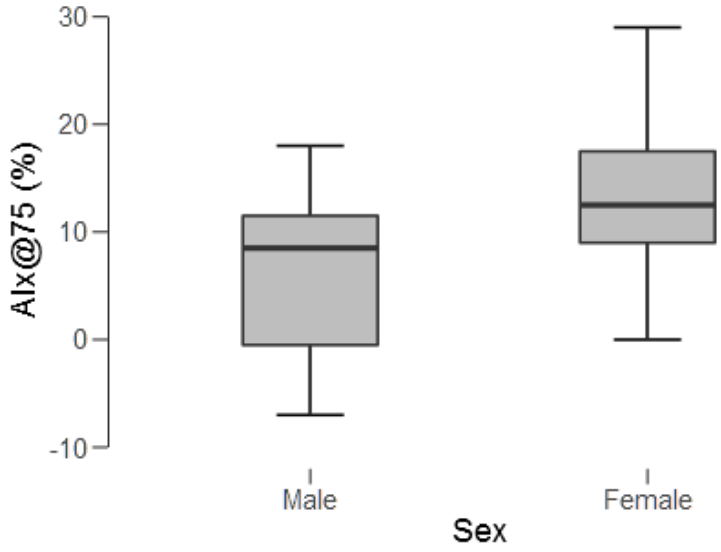

Figure 5: Differences in AIx@75 between male and female students.

Discussion (Michael)

The aim of the present investigation was to compare 24 sport students of both sexes and various athletic background in regard to two simply assessable, non-invasive measures of CAS.

Kurzfassung:

PWV as a direct measure of CAS (Obara, 2009) was significantly lower in endurance compared to strength trained students as expected from previous research (Sardelli, 2018). Although in part related to PWV (Kelly,

2001), AIx@75 did neither differ between groups nor correlated with PWV which indicates its dependence on various factors besides CAS, including vascular tone (Haapala, 2018) and body height (Yasmin, 1999). In dilated peripheral arteries and longer central arteries, the pulse wave may be reflected later resulting in higher AIx@75 without affecting PWV values (Kelly, 2001 & Yasmin, 1999). Since body height and peripheral resistance were correlated with AIx@75 unlike with PWV, our results partly support those influence factors. Likewise, female athletes exhibited significantly higher AIx@75 values with lower PWV in part due to their smaller height compared to men.

Limitations:

- indirect measurement of CAS

- heterogeneity of subjects with regard to their physical activity

- standardized preparation of the subjects to minimize the influence of peripheral resistance on AIx@75

Conclusion:

In conclusion, endurance trained students exhibited a lower CAS compared to strength trained students as shown by lower PWV unlike AIx@75 values influenced by various other factors besides CAS.

Ausführliche Fassung:

The main finding of the investigation is that sport students with a background in endurance-type exercise exhibit lower CAS in comparison with strength trained participants as shown by significantly lower PWV values. In contrast, no difference between strength and endurance trained participants was found regarding AIx@75. In addition, female students showed lower PWV values whereas AIx values were significantly higher compared to their male equivalents. The nonexistent correlation (r=. . .) between the two parameters of CAS reflects the apparently equivocal results.

Although some studies reported strong correlations between the two parameters which have been shown representative for CAS, they are affected by different factors. PWV is measured . . . by the Arteriograph while AIx@75 is composed of. . . Thus, though heart rate corrected, AIx@75 is strongly influenced by height showing an inverse relationship (London, 1995) as well as by peripheral resistance (Quelle).

Accordingly, a significant negative correlation between AIx and height was found (r=0.505) while PWV was not associated with height (r=. . .). Therefore, it is not surprising that female students (exhibiting smaller heights than thier male counterparts (p=0.038) showed significantly higher AIx@75 values although PWV values were clearly lower indicating a basically lower CAS (London, 1995).

In addition to the dependence of AIx@75 from height, which partly explains the differences in AIx@75 and PWV between sexes, the AIx@75 (r=0.505) unlike PWV was related to peripheral resistance. This may have contributed to the equivocal effect between sexes with peripheral resistance values being clearly higher, even though not significantly, in females (r=0.071).

Furthermore, a higher peripheral resistance may at least partly explain the differences between strength and endurance athletes. Since endurance trained exhibited higher (though not significantly) peripheral resistance values (p=0.096), this could have favored higher AIx@75 values although CAS has actually been lower as shown by the significantly lower PWV. A current investigation underpins this observation by showing . . . (Haapala, 2018)

The dependence of AIx@75 from different influence factors like height and peripheral resistance as well as the quite active experimental group could have led to the poor relationship between both variables favoring PWV in assessing CAS.

Limitations

Nevertheless, it is acknowledged that there are limitations to the current study. Since especially the AIx@75 depends from peripheral resistance, it would have been useful to equally prepare the subjects prior to the investigation to minimize potentially confounding influences of nutrition, activity, sleep, coffein consume, etc. on peripheral resistance (Quelle?) to warrant higher between-subject comparability. Futhermore, the strong heterogeneity of participants‘ sporting backgrounds with different weekly training volumes made it difficult to clearly distinguish between strength and endurance athletes so that for example team sport athletes were assigned to endurance trained even if they regularly absolve strength training sessions.