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# ASSESSING THE ASSOCIATION OF HANDGRIP STRENGTH WITH ARTERIAL STIFFNESS AMONG YOUTH AT WSU

**KEY WORDS:** Handgrip Strength; Sphygmocor; Arterial Stiffness.

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**ABSTRACT**

Arterial stiffness is the hardening of arterial walls, reducing the capability arteries to expand and contract in response to pressure changes. This study was done to determine if handgrip strength is associated with arterial stiffness among WSU students of Mthatha campus in Nelson Mandela Drive. A total of 102 healthy students (50 females and 52 males) participated in the study. The data was collected using sphygmocor, stadiometer, omronModel HBF-500, tape measure and hand dynamometer and statistically analyzed using statistix version 8.1 software and Microsoft excel for graphs. Arterial stiffness increases with increasing body composition $p<0.008$. There was negative insignificant association between hand grip strength and arterial stiffness ($p<0.2$). Arterial stiffness is associated with body composition and hand grip strength. This study has demonstrated that, arterial stiffness increases with increasing body composition. People with arterial stiffness were found to have low handgrip strength. Arterial stiffness is positively associated with body composition but negatively related to hand grip strength.

## INTRODUCTION

Arterial stiffness is the hardening of arterial walls reducing the capability arteries to expand and contract in response to pressure changes caused by slow build up of plaque on the inside of arterial walls and is related to high blood pressure and hypertension [1]. The factors that affect arterial stiffness are age, sex and blood pressure [2]. Increased arterial stiffness is an independent predictor of cardiovascular disease and mortality in middle-aged and older adults [3]. The burden of cardiovascular disease (CVD) in the world is enormous and growing, mostly affecting people living in developing countries [4]. Cardiovascular disease (CVD) has increased to nearly 80% of the burden now occurring in developing countries caused by lack of monitoring non-communicable diseases [5]. CVD is caused by many lifestyle factors which include lack of exercise and diet causing arterial stiffness [6].

The incidence of heart disease risk factors is prevalent amongst teenagers and young adults [7]. Several non-invasive methods are currently used to assess vascular stiffness [8]. Pulse wave velocity (PWV) and the augmentation index (AI) are the 2 major non-invasive methods of assessing arterial stiffness. However, equipments used for these assessments are costly and not user friendly among the youth as first line screening tools. Therefore there is urgent need to identify a simple, cheap and easily acceptable tool to the youth.

Handgrip strength [HGS] is said to correlate with general health status and it is used to screen for efficiency in cricket players [9]. An individual's handgrip strength (HGS), measured by a hand dynamometer, has shown significant correlations with clinical conditions such as malnutrition, type 2 diabetes, functional disability, stroke hypertension and overall quality of life [10]. However, no studies have evaluated the association of HGS with arterial stiffness among the youth in rural African setting, a risk factor of cardiovascular diseases. Therefore the aim of this study is to determine if handgrip strength is associated with arterial stiffness among student population at WSU, Mthatha, South Africa.

## METHODS

### SUBJECT AND STUDY DESIGN

#### Subject selection

100 Healthy volunteer students (age between 18-28 years) from Walter Sisulu University (50 females and 50 males) were randomly selected after informed consent. Those who had history of chronic disease will be excluded. Those who had had any surgery on both their left and right arm, hand or wrist in the last three months or had arthritis or pain in both their left and right hand or wrist will be excluded from the study.

### DATA COLLECTION

#### Blood Pressure measurement

Participants were asked to sit quietly for at least 2 minutes. They were then cuffed with an Omron RX Electronic Sphygmomaometer (digital blood pressure machine) in their left upper arm while still seated. The cuffing will go on until a stable reading of the heart rate, systolic blood pressure and diastolic blood pressure were obtained.

#### Handgrip strength measurements

The subject was asked to hold the dynamometer in the hand to be tested, with the arm at right angles and the elbow by the side of the body. The handle of the dynamometer is adjusted if required, the base should rest on first metacarpal (heel of palm), while the handle should rest on middle of four fingers. When ready the subject squeezes the dynamometer with maximum isometric effort, which will be maintained for about 3 seconds and will be recorded as handgrip strength in kilograms (kg). No other body movement is allowed. The subject was encouraged to give a maximum effort.

#### Pulse wave velocity

Carotid-femoral (aortic) pulse wave velocity shall be measured using the SphygmoCor (At Cor Medical Pty. Ltd., Sydney, Australia) device by sequentially recording ECG-gated carotid and femoral artery waveforms with a tonometer (SPC- 301; Millar Instruments, Texas, U.S.A.) for 32 seconds. The timing of these waveforms shall be compared with that of the R wave on the simultaneously recorded ECG. For the carotid wave measurement, the subject was asked to lie on a bed with the head tilted slightly to the back and to the left. The position for the strongest pulse was palpated and the tonometer was placed directly on the top of the skin at this point. The femoral measurement was also done with the subject lying on a bed, with the thigh flexed at the hip joint, moved away from the midline of the body and rotated away from the body. The pulse is best felt midway between the anterior superior iliac spine and the pubic symphysis. This is where the tonometer was placed.

Pulse wave velocity was determined by calculation of the difference in carotid to femoral path length divided by the difference in R wave to waveform foot times. The difference in carotid to femoral path length was estimated by calculating the distance from the supra-sternal notch to the femoral pulse point, and from the supra-sternal notch to the carotid pulse point respectively measured in a direct line.

**Pulse wave analysis**

After at least 5 minutes of rest, brachial blood pressure was recorded from the dominant arm using an aneroid sphygmomanometer. Pulse wave reflection was measured with the SphygmoCor pulse wave analysis System (AtCor Medical Pty. Ltd., Sydney, Australia). Radial artery waveforms were recorded non-invasively at the wrist of the dominant arm with an applanation tonometer (SPC-301, Millar Instruments, Houston, Texas, U.S.A.) by flattening, but not occluding, the radial artery of the dominant arm with gentle pressure. The waveforms were collected into a personal computer and the Sphygmo Cor software was used to generate the corresponding aortic waveforms using a validated transfer function.

The aortic AIx was calculated as the augmentation of the aortic systolic pressure by the reflected pulse wave expressed as a percentage of the aortic pulse pressure. Because AIx is influenced by heart rate, it was adjusted to a heart rate of 75 bpm by the software. Central and mean arterial blood pressure was calculated from the digitized brachial blood pressure curve. The time to return of the reflected wave (Tr) was calculated as the time from the beginning of the derived aortic systolic pressure waveform to the inflection point. Tr can be used as a substitute for pulse wave velocity (a higher pulse wave velocity will result in a shorter Tr)  All measurements were subjected to quality control by the software and only high-quality recordings, defined as a quality index 80% were included in the analyses.

**Handgrip strength measurements**

The subject held the Jamar® smart hand dynamometer (Manufactured by Patterson MedicalL Ltd) in the hand to be tested, with the arm at right angles and the elbow by the side of the body. The handle of the dynamometer was adjusted if required, the base should rest on first metacarpal (heel of palm), while the handle should rest on middle of four fingers. When ready the subject squeezed the dynamometer with maximum isometric effort, which was maintained for about 3 seconds and was recorded as handgrip strength in kilograms (kg). No other body movement was allowed. The subject was strongly encouraged to give a maximum effort.

**Ethical considerations**

The ethical clearance was obtained from the Walter Sisulu University ethical committeewith protocol number 061/2016. All volunteering participants signed the consent form prior to participation and the study induced no harm to the subjects.

**Data presentation and analysis**

Statistical analysis was carried out using SPSS for statistix (version 8.1software). Pearson's correlation was used to determine the association of arterial stiffness with hand grip strength. The results were expressed as mean ±SEM for normally distributed values and as median (range / inter-quartile) range for non-normal.

## RESULTS

**Table 1: Correlation of body composition with Arterial stiffness among all participants.**

| Arterial stiffness parameters | W/H | | BMI | | %SM | | BMR | |
|---|---|---|---|---|---|---|---|---|
| | R | P | R | P | R | p | R | p |
| P_Aix | .066 | .531 | -.055 | .603 | .089 | .398 | .027 | .798 |
| C_SBP | .274 | .008 | .218 | .037 | .251 | .016 | .369 | .000 |
| CPP | .197 | .059 | .099 | .348 | .265 | .011 | .240 | .021 |
| C_Aix | .086 | .416 | .082 | .437 | .023 | .826 | .085 | .423 |
| C_AIx-75 | -.04 | .693 | .206 | .049 | -.188 | .072 | .040 | .709 |

r is Pearson correlation coefficient.,p value is the significance level p is <0.05.

Peripheral Augmentation Index (P_AIx), Central Systolic Blood Pressure (C_SBP), Central Pulse Pressure (CPP), Central Augmentation Index (C_AIx), Central Augmentation Index @75bpmn (C_AIx-75).

As seen in table 1 above, central systolic blood pressure is significantly associated with body composition ($p<0.05$), central pulse pressure are significantly associated with Basal metabolic rate, percentage of skeletal muscle and waist/hip ratio ($p<0.05$).

There is negative insignificant correlation between arterial stiffness and most body composition parameters. $P>0.05$.

There was no significant correlation between arterial stiffness variables and hand grip strength (Table 2 & 3) although pAlx, cAlx and cAlx@75 were  negatively related to HGS in both females and males.

**Table 2: Correlations between Hand Grip Strength and arterial stiffness among females.**

| Arterial stiffness | r-value | p-value |
|---|---|---|
| Peripheral Augmentation Index | -.053763 | .710774 |
| Pulse Pressure Amplification | .096161 | .506494 |
| Central Augmentation index | -.038962 | .788212 |
| Central Augmentation Index @75bpm | -.042806 | .767868 |

r is Pearson correlation coefficient and p value is the significance level p is <0.05.

**Table 3:  Correlations between Hand Grip Strength and arterial stiffness among males.**

| Arterial stiffness | r-value | p-value |
|---|---|---|
| Peripheral Augmentation Index | -0.2190 | 0.126 |
| Pulse Pressure Amplification | 0.1214 | 0.401 |
| Central Augmentation index | -0.0595 | 0.681 |
| Central Augmentation Index @75 | -0.0195 | 0.892 |

r is Pearson correlation coefficient ; p value is the significance level when p is <0.05.

**Table 4: Correlations between arterial stiffness and Hand Grip Strength in all participants.**

| Arterial stiffness parameters | r-value | p-value |
|---|---|---|
| Peripheral Augmentation Index | .022 | .829 |
| Pulse Pressure Amplification | -.119 | .247 |
| Central Augmentation index | .042 | .687 |
| Central Augmentation Index @75 | -.116 | .260 |

r is Pearson correlation coefficient and p value is the significance level when p is <0.05.

Arterial stiffness is insignificantly correlated to HGS. And the coefficient shows negative correlation in PPA and C_AIx-75 (Table 4).

## DISCUSSION

The aim of this study was to determine if handgrip strength is associated with body composition and arterial stiffness among WSU students. An overview of CVS risk factors burden in sub-saharan Africa was analysed [11].

In this study it was found that the arterial stiffness is high in participants with high body composition. Using central systolic blood pressure, arterial stiffness is affected by waist hip ratio, body mass index, percentage of skeletal muscle and basal metabolic rate and was negatively associated with body fat percentage. Arterial stiffness was found to increase with increasing body composition among all participants. High levels of leptin have been documented in individuals with obesity and found to be correlated with reduction in arterial compliance [12].

This study has shown that, arterial stiffness is affected the same way with hand grip strength among different genders, in both males and females. In this study, arterial stiffness was found to increase with decrease in hand grip strength. It is also pertinent to note that CVS risk factors have been reported in college students [7] in a different setting, making this study unique as this is the first of its kind in African setting.

## CONCLUSION

People with arterial stiffness were found to have low handgrip strength. Body composition is not associated with hand grip strength, as body composition parameters increases, the muscle become weaker and hand grip strength decrease. Arterial stiffness is positively associated with body composition but negatively related to hand grip strength.

## RECOMMENDATIONS

Arterial stiffness may be influenced by several factors like age, gender, diet and lifestyle. When conducting a study of arterial stiffness, larger sample can increase precision. Fasting can be helpful to decrease variability on activity of autonomic nervous system caused by different diets.

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