Limb Length and Lifting Capacity: A Correlation Analysis

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Introduction

There are limited studies on the direct relationship between limb length and lifting capabilities. Previous studies have looked at topics such as differing lengths of the moment arm and power/work output [1], the relationship of lifting capacity and general anthropometric measures [2], and give a general description of the potential relationships between certain physical features and muscle force production. Other researchers have looked at the height and limb length of various swimmers and their propulsive force [3], the sarcomere and extremity length in force production in frogs, and the potential relation to humans [4]. A final study looked at the observed effects of lever lengths, angles, and weight lifting ability [5]. The purpose of this study is to confirm or disprove the idea that shorter arms increase lifting capacity when performing a preacher curl.

Methods

- **Twenty-seven individuals participated in this study (23 males, 4 females, average age 24.19 years, trained for a minimum of 3-6 weeks actively strength training). Participants completed a series of anthropometric measurements, which included an In-Body examination (for lean muscle mass per upper limb) and measurements of the total wingspan (tip of the 3rd digit to tip of the 3rd digit), full arm (acromion process to fingertip), and lower arm segment (lateral condyle to the tip of 3rd digit). The subjects were then guided through a warm-up regimen (as outlined by the ACSM) to prep for a preacher curl one-rep max test. The warm-up regimen consisted of 8-10 reps at 40-60% estimated 1 rep max. The subjects rested for 1-minute and then completed 3-5 reps of 60-80% of the estimated 1 rep max. The subjects rested for a 2-minute period before attempting an estimated one-rep max. A failed attempt resulted in a decrease in weight and a 2-minute rest period until the 1 rep max preacher curl lift was attempted again. This was repeated until a successful one rep max was obtained. A linear regression looked for potential relationships between gathered information and results found. Subjects' weight lifted was normalized through dividing the weight of the subject lifted by a calculated value produced by dividing the arm average lean mass by average arm length. Through normalized weight lifted (NWL), body mass differences were accounted for. The average arm length (AAL) was compared to the NWL along with average lower arm length (ALAL) and wingspan (WS). The actual weight lifted (WL) values were also compared to AAL, ALAL, WS, and average lean mass (ALM).**

Results

Table 1: Calculated values from regression tests

	R Value	P Value	X Stan. Dev.	Y Stan. Dev.
NWL/AAL	0.4120	0.0327	2.018	47.240
NWL/ALAL	0.4112	0.0331	1.024	47.240
NWL/WS	0.3032	0.1242	4.730	47.240
WL/AAL	0.6066	0.0008	2.018	24.666
WL/ALAL	0.5453	0.00326	1.204	24.666
WL/WS	0.4996	0.0008	4.360	24.666
WL/ALM	0.8743	0.0000	1.974	24.666

Results and Discussion

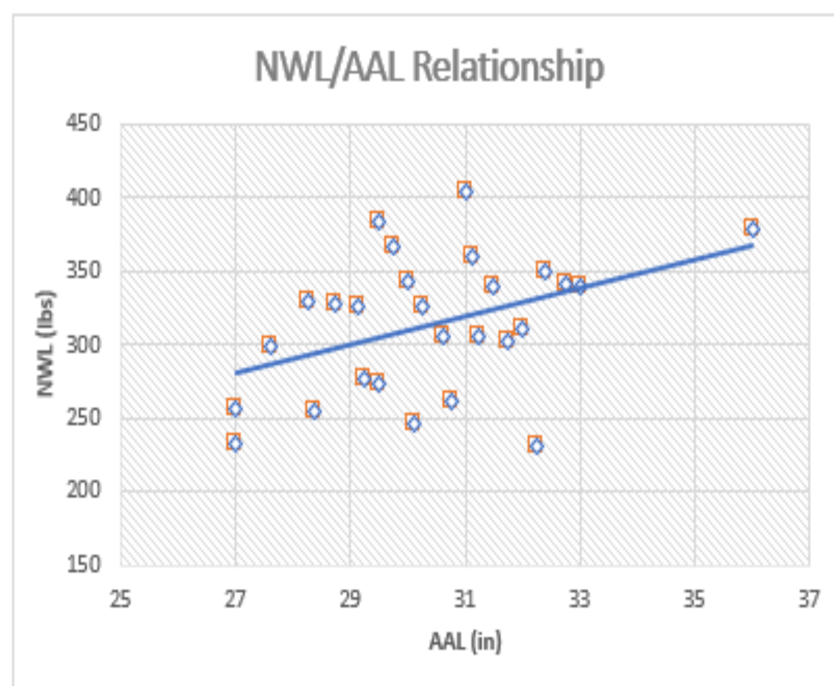
Statistical test showed most had no strong (R equal to or greater than 0.7) relationship between any limb length measurement and lifting capacity. The majority of the tests produced moderate relationships (R between 0.4 and 0.6). The only test that produced a strong relational value was the WL/ALM comparison (R = 0.8743). All tests but one produced statically significant (P being less than 0.05) values. Figure 1 shows a table of all R, P, and X / Y standard deviation values. When looking at all of the produced results, no values support the idea that shorter arms increased lifting capabilities. Figure 2 shows graphs showing the positive R values, and the slope indicating increased lifting capabilities as limb length increases.

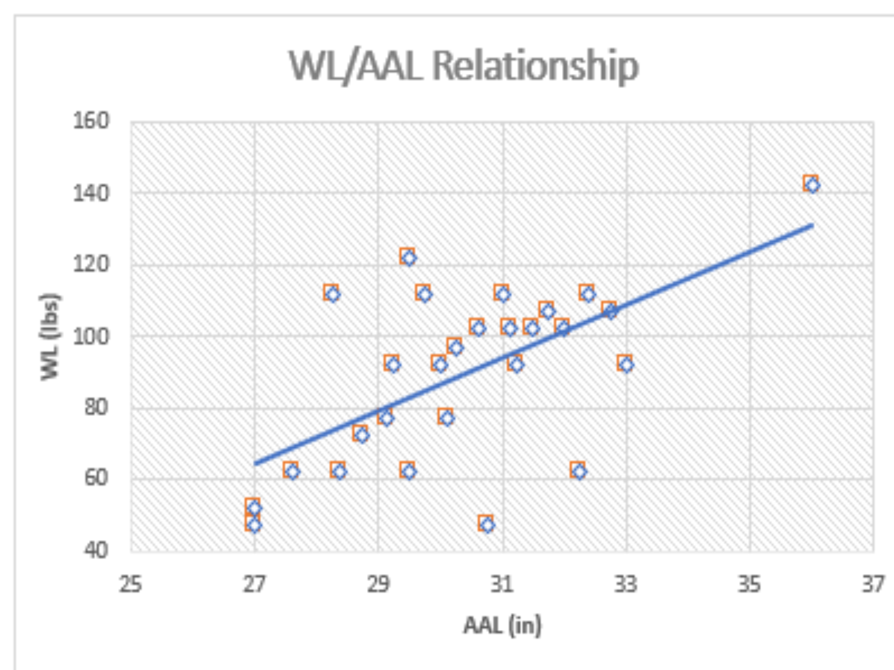
Not only do these results fail to support the idea of shorter arms having an advantage, they show a contrary idea that longer arm lengths were able to lift more weight while performing the preacher curl.

Possible explanations for this include the following: as muscle mass increases, lifting capacities increase. As limb length increases, we see an increase in lean muscle mass in the arms, thus showing that with increased muscle mass in longer arms, lifting capacity increases. Another potential explanation lies in the difference in resistance and force arm lengths between long/ short arm individuals. As arm length increases, the resistance arm increases. The question then arises, if resistance arm increases, does force arm (length of insertion point of the muscle) increase as well? Perhaps the lengthening of the force arm provides further lifting abilities in individuals with longer arms. Regardless of the potential explanation, shorter arm individuals did not have an increase ability or advantage in lifting more weight.

Limitations to this experiment include only using trained individuals and performing only one lifting activity.

Figure 2: Example Graphs of Correlation Tests





Conclusion

With the data gathered from the twenty-seven participants, we concluded after statistical tests were run, there is no advantage that comes from having shorter limbs when performing a preacher curl. In contrast, potential relationships show the length of the arm had a moderate effect on the

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