IS THERE ANY EFFECT OF NON-SUITABLE PULL TECHNIQUE IN BACK & LEG DYNAMOMETERS ON THE LEG STRENGTH TEST RESULTS?

Ender Eyuboglu1, Cem Sinan Aslan2, Izzet Karakulak3, Fatma Nese Sahin4
1Bartın University The School of Physical Education and Sports, Bartın, Turkey - 2Burdur Mehmet Akif Ersoy University The School of Physical Education and Sports, Burdur, Turkey - 3Artuklu University The School of Physical Education and Sports, Mardin, Turkey - 4Ankara University Faculty of Sport Sciences, Ankara, Turkey

ABSTRACT

Introduction: Dynamometers are valid and reliable test instruments that have been used for many years to measure strength. However, there are excessive differences in leg strength scores in different studies with similar groups. This situation suggests a non-conformity to testing procedures occurred during the practice of the tests. The purpose of this study was to determine the effect of non-suitable pulling technique on the leg strength test results.

Materials and methods: A total of 127 healthy subjects (24 female athletes and 41 male athletes, 22 sedentary females and 40 sedentary males) were included in the study. A back & leg Dynamometer was used to determine the leg strength of the participants. The participants pulled up the dynamometer’s grab handle with and without contact with their upper leg.

Results: The results showed that there was a significant difference (p=0.000) between contacted and non-contact pulling trials of all participants. The percentage difference of leg strength between contacted and non-contact pull was 51.69% (43.25 kg) for female athletes, 54.78 (73.46 kg) for male athletes, 56.31% (37.52 kg) for sedentary females, and 50.69% (65.55 kg) for sedentary males.

Conclusion: There were significant differences between contacted and non-contact pull trials. It was determined that during the pulling phase if the dynamometer’s grab-handle contacted the upper leg of a subject, the strength measurement’s score increased considerably. In this case, it can be said that non-suitable pulling technique in the “back & leg dynamometers” affects the leg strength test scores.

Keywords: Back & Leg Dynamometer, Leg Contact, Reliability of Measurement.

DOI: 10.19193/0393-6384_2019_3_211

Received November 30, 2018; Accepted February 20, 2019

Introduction

Measurement is one of the important components of performance assessment in sports. They can give knowledge about the physiological needs of the players, help coaches to prepare training programs, identify needs and problems such as energy expenditure of the players or reduce the risk of injury(1-3). Even though testing and measurements are two important components of performance assessment, some details during the procedures that may seem underestimated may however directly affect the test results.

An isometric muscle contraction is when force is applied to a muscle and no movement is seen at the joint(4). Some apparatus, as strength dynamometers can be used to measure the maximum force applied through an isometric contraction. Strength dynamometers are usually composed of a cable tensiometer. They have been known as valid and reliable devices in order to estimate strength(5,6).

Back & Leg dynamometers are instruments used to measure the maximum isometric strength of the back and leg muscles and tracking improvements of strength training and/or rehabilitation of individuals.
And these are also known to be commonly used in medical science\(^7\)-\(^10\).

Although dynamometers are valid and reliable test instruments that have been used for many years for measuring strength\(^5\),\(^6\), it is seen that there are excessive differences in leg strength scores in many studies which have compared similar groups\(^11\)-\(^16\). When the literature is reviewed, it is seen that leg strength results measured via back & leg dynamometers have quite sharp fluctuations in all age and gender groups. This situation suggests that there might be different test assessment methods. The purpose of this study was to determine the effect of non-suitable pulling technique (if the dynamometer’s grab-handle is contacted with the upper leg of a subject during pulling phase) on the leg strength test results.

**Materials and methods**

**Participants**

Forty-six female and eighty-one male (of which, 24 female and 41 male athletes, and 22 female and 40 sedentary males) subjects participated in this study.

Before data collection, written informed consent was obtained from all subjects, and the university’s institutional review board for the protection of human subjects approved the investigation. The study was performed in compliance with the Helsinki Declaration.

**Procedures**

Participants’ leg strength was measured with the Takei T.K.K. 5402 (Japan) Back & Lift Dynamometer, which is a simple and popular device to test back, legs and chest strength with a sensitivity up to 300 kg. The device features an adjustable length chain to accommodate for height differences or to vary the point of force application. An LCD screen on the front of the dynamometer had been applied in order to display the results.

Each participant had to perform 4 pulling trials. Two of which realized with the leg contacted (LC-shown in figure 1) to the dynamometer’s grab-handle and, the other two which were without leg contact (WLG-shown in figure 2). The best performances were recorded for each trial.

Although back & leg dynamometer test procedure can be defined as follows according to literature\(^17\),\(^18\), there is no current evidence if it needs to contact or not with the leg during the testing procedure.

Ten Hoora et al\(^17\) and Tamer\(^18\) have described the test procedure as follows:

- Make sure the dial is reset to zero before the participant starts. He/she stands upright on the base of the dynamometer with the feet shoulder width apart. He/she should let his/her arms hang straight down to hold the centre of the bar with both hands, and with the palms facing toward the body.
- The participant should adjust the chain so that the knees should be bent at approximately 110 degrees. In this position participant’s back should be bent slightly forward at the hips, head should be held upright, and he/she should look straight ahead. Then without bending his/her back, he/she pulls as hard as possible on the chain and tries to straighten legs, keeping arms straight.
- The participants should pull against the weight steadily (no jerky movements), keeping the feet flat on the base of the dynamometer. Maximum performance will result when his/her legs are almost straight at the end of the lift. If not, he/she has to adjust the chain length and starting position.

**Data analysis**

Data were analysed with IBM SPSS statistics software (© copyright IBM corporation, version 16.0). The descriptive analysis was performed by calculating the means and standard deviations (Std). Because of the assumption of normality was
verified using the Shapiro-Wilk test, Paired Samples t-tests were used to compare groups. "α" was set as 0.05.

Results

The participants showed the following values for age, height and body mass respectively; 20.96 years, 165.37 cm and 58.54 kg for female athletes, 22.46 years, 177.05 cm and 72.19 kg for male athletes, 21.50 years, 161.00 cm and 61.33 kg for sedentary females, and 22.62 years, 174.55 cm and 70.60 kg for sedentary males.

Table 2: Paired samples test of contacted and non-contact pulling. The results of this study such as participants’ age, height, body mass, and leg strength were similar to most of other studies of the literature(11, 13, 14, 19, 20, 21).

Muscular strength is one of the main physical components and is associated with the many everyday activities and sports performances(22, 23). To quantify and classify the levels of strength and performance is therefore very important in the decision making for physical exercise and therapy prescription(24). Therefore, measurements must be performed without error.

When the related studies which have examined similar groups reviewed, it was seen that there are excessive differences in determined leg strength scores. For example; Gelen et al.(11) in their study; found leg strength of a group male tennis players as 185.10 kg, but Koley et al.(25) found for male cricketers as 52.36 kg. Marrin and Bampouras(13) found leg strength of elite female water polo players as 134.20 kg, whereas Aslan and Cinar(14) found 76.90 kg in female athletes. In other examples realized with young persons; Karadenizli et al.(15) found young soccer players’ leg strength as 180.17 kg and handball players’ 179.84 kg, and Basar et al.(26) 215.96 kg for young wrestlers, while Eyuboglu and Aslan(27) found 103.18 kg for young soccer players. In sedentary individuals; Aslan and Cinar(14) found 87.00 kg in males, and 58.10 kg in females, however Ramsbottom et al.(16) found as 108.00 kg on average in males and females and also, Ten Hoor et al.(17) determined leg strength as 132.50 kg for males and 56.30 kg for females. Similar study examples can be further increased.

The results of this study indicate that there were significant differences between contacted and non-contact pull trials. The percentage difference of leg strength between contacted and non-contact pull was 51.69% for female athletes, 54.78% for male athletes, 56.31% for sedentary females and 50.69% for sedentary males. In this case, it can be said that non-suitable pulling technique in "back & leg dynamometers" dramatically affects the leg strength test scores in both athletes and sedentary individuals.

During the pulling phase, if the dynamometer's grab-handle contacts to the upper leg of a subject, the force scores of the participants increase

<table>
<thead>
<tr>
<th>Gender</th>
<th>Situation</th>
<th>N</th>
<th>Pair Mean</th>
<th>Std. Dv</th>
<th>Std. Me</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female</td>
<td>Athletes 24 Non-Contact</td>
<td>83.37</td>
<td>9.41</td>
<td>1.92</td>
<td></td>
</tr>
<tr>
<td>Sedentary 22 Non-Contact</td>
<td>66.89</td>
<td>14.60</td>
<td>3.11</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>Athletes 41 Non-Contact</td>
<td>133.79</td>
<td>18.12</td>
<td>2.83</td>
<td></td>
</tr>
<tr>
<td>Sedentary 40 Non-Contact</td>
<td>129.81</td>
<td>22.31</td>
<td>3.53</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 1: Descriptive statistics of participants’ Tests Scores. Mean and std dv are expressed as Kg; Std. Me= Standard mean error

In Table 1; descriptive statistics of participants’ “ack & Leg” dynamometer test scores, in Table 2; the comparison test results, and in Table 3; the percentage differences between "contacted and non-contact" pulling trials were shown.

<table>
<thead>
<tr>
<th>Gender</th>
<th>Situation</th>
<th>Mean</th>
<th>Std. Dv</th>
<th>Std. Me</th>
<th>Paired Differences</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female</td>
<td>Athlete</td>
<td>-43.25</td>
<td>18.35</td>
<td>3.75</td>
<td>-51.00 -35.50 -11.544</td>
</tr>
<tr>
<td>Sedentary</td>
<td>-37.52</td>
<td>17.20</td>
<td>3.67</td>
<td>-45.15 -29.90 -10.231</td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>Athlete</td>
<td>-73.46</td>
<td>30.52</td>
<td>4.77</td>
<td>-83.10 -63.83 -15.412</td>
</tr>
<tr>
<td>Sedentary</td>
<td>-65.55</td>
<td>33.06</td>
<td>5.23</td>
<td>-76.13 -54.98 -12.540</td>
<td></td>
</tr>
</tbody>
</table>

Table 2: Paired samples test of contacted and non-contact pulling. Mean and std dv are expressed as Kg; Std. Me= Standard mean error; t= The symbol of the division of the mean difference to the standard error; df= Degrees of freedom

<table>
<thead>
<tr>
<th>Gender</th>
<th>Situation</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean</th>
<th>Std. Dv</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female</td>
<td>Athlete</td>
<td>24</td>
<td>14.37</td>
<td>92.50</td>
<td>51.69</td>
</tr>
<tr>
<td>Sedentary</td>
<td>22</td>
<td>21.34</td>
<td>114.58</td>
<td>56.31</td>
<td>23.07</td>
</tr>
<tr>
<td>Male</td>
<td>Athlete</td>
<td>41</td>
<td>14.95</td>
<td>96.25</td>
<td>54.78</td>
</tr>
<tr>
<td>Sedentary</td>
<td>40</td>
<td>14.93</td>
<td>104.49</td>
<td>50.69</td>
<td>24.05</td>
</tr>
</tbody>
</table>

Table 3: Percentage difference between contacted and non-contactpulling. Mean and std dv are expressed as Kg; Std. Me= Standard deviation
considerably. It is known that the principle of the leverage, a lever provides to do more work with less force to lift or move objects. Since a lever is a tool, its object is to assist in distributing strength or speed to the best advantage.

The cause of strength increasing at the "contacted pulling phase" in this study can be explained via the leverage effect providing by the legs when contacting the grab-handle. In future studies, the reason for this may be explained clearly by the determination of the muscle activation via electromyography (EMG) at the pulling phase.

As a result, differences between test scores may indicate that different pulling techniques measuring strength results might have been obtained incorrectly. For this reason, while performing a leg strength test with a dynamometer, researchers should be careful that the grab-handle should not come into contact with the subject's upper leg during the pulling phase.

References


Corresponding Author:
CEM SINAN ASLAN
Mehmet Akif Ersoy Universitesi, Besyo Bahcelievler mah. TR15000 Burdur
Email: sinancm@hotmail.com (Turkey)