
# University of Jordan

## School of Engineering

## Department of Industrial Engineering

## Course ID: 0936482

## Human Factors and Work Measurement Laboratory


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## *Introduction*

In our last experiment we measured body strength by measuring grip strength, since it is a good indicator of the whole-body strength. In this experiment, we are interested in measuring the endurance through the static (isometric) strength of the body's skeletal (voluntary) muscles in a sitting posture using the hand dynamometer. Muscle endurance is the muscle's ability to withstand multiple contractions over a period of time, without fatigue or wearing out. We will also measure the maximum voluntary contraction, which is a measure of the muscle's maximum static load capacity. As mentioned previously, there are two types of body strength, 1- Static strength: Static strength-endurance implies isometric tension of varying magnitude and duration or in holding a specific posture. It is associated with relatively long or short-term sustained muscular tension; its importance determines its time in each case. 2. Dynamic strength: Dynamic strength-endurance is typically associated with cyclic exercises in which considerable tension is repeated without interruption during each cycle of movement. It also appears in acyclic events requiring maximum power repetitions with short rest periods such as jumping or throwing activities.

## *Procedure*

1. Set the hand dynamometer's grip span to 5 cm.

2. Ensure that the Hand Dynamometer's reading is set to zero.

3. Place the Hand Dynamometer in an upright posture along the sides and allow the student to sit with their feet flat on the floor and their back straight.

4. With the support of the forearm on the chair armrest, the elbow must be at a 90° angle.

5. Place your dominant hand on the Hand Dynamometer.

6. The student maintains a firm grip on the hand dynamometer for three seconds.

7. List the money each student has registered as (MVC) for each student.

8. Determine the typical MVC.

## *Apparatus*

The hand dynamometer (evaluation tool) measures isometric grip force (hand grip strength). Additionally, the spring contracts during a grip test, which gives the handle a dynamic action. -It has an adjustable grip for the best fit and a dual pointer system to maintain the maximum effort.

## *Data Collected*

The attached figures show us the identified values for the full grip strength, 60%,40% and 15% respectively for each student participated in this experiment.

| Name | 100% | time(s) | 60% | time(s) | 40% | time(s) | 15% | time(s) |
|---|---|---|---|---|---|---|---|---|
| **Females** | | | | | | | | |
| **Dina** | 40 | 3 | 24 | 44 | 16 | 78 | 6 | 180 |
| **Tamara** | 14 | 3 | 8.4 | 16 | 5.6 | 119 | 2.1 | 240 |
| **Rifqa** | 22 | 3 | 13.2 | 20 | 8.8 | 42 | 3.3 | 120 |
| **Noor Zaatreh** | 16 | 3 | 9.6 | 47 | 6.4 | 120 | 2.4 | 73 |
| **Hiba Jaouni** | 28 | 3 | 16.8 | 22 | 11.2 | 34 | 4.2 | 120 |
| **Hiba Shawabkeh** | 30 | 3 | 18 | 40 | 12 | | 4.5 | |
| **Males** | | | | | | | | |
| **Omar Aljundi (non-smoker)** | 38 | 3 | 22.8 | 22 | 15.2 | 42 | 5.7 | 141 |
| **Mohammad Alkhalaileh (non-smoker)** | 36 | 3 | 21.6 | 7 | 14.4 | 25 | 5.4 | 78 |
| **Omran (non-smoker)** | 44 | 3 | 26.4 | 15 | 17.6 | 44 | 6.6 | 73 |
| **Mohammad Salameh (non-smoker)** | 40 | 3 | 24 | 17 | 16 | 44 | 6 | 101 |
| **Mohammad Awwad (non-smoker)** | 46 | 3 | 27.6 | 15 | 18.4 | 36 | 6.9 | 89 |
| **Hussam (smoker)** | 70 | 3 | 42 | 23 | 28 | 52 | 10.5 | 134 |

*Table1: The Time endurance measured for sample of students.*

# *Discussion*

According to what we've known in human factors, "as a general rule, maximum muscle strength can be sustained for only a few seconds; 50% of strength is available for around a minute; less than 20% can be used consistently for long periods of time."

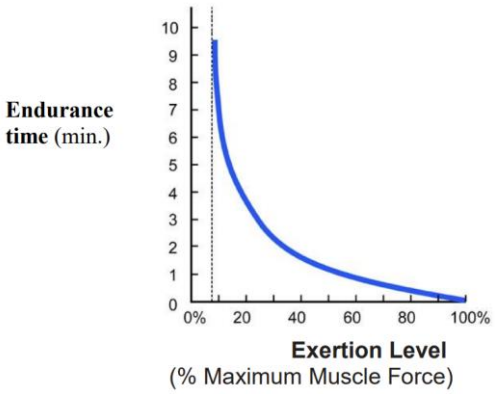


*Figure1: Endurance time*

During this experiment, this principle is being tested to see whether such thing exist or not, we'll be explaining thoroughly how endurance time can vary within a specified sample of males and females and why ***women*** have higher **endurance;** which can also be defined by the ***ability to withstand certain levels of lactic acid built up in muscles, and women are usually less tired once they have completed a task***.

We can see from the attached tables that Hussam had the highest score of full

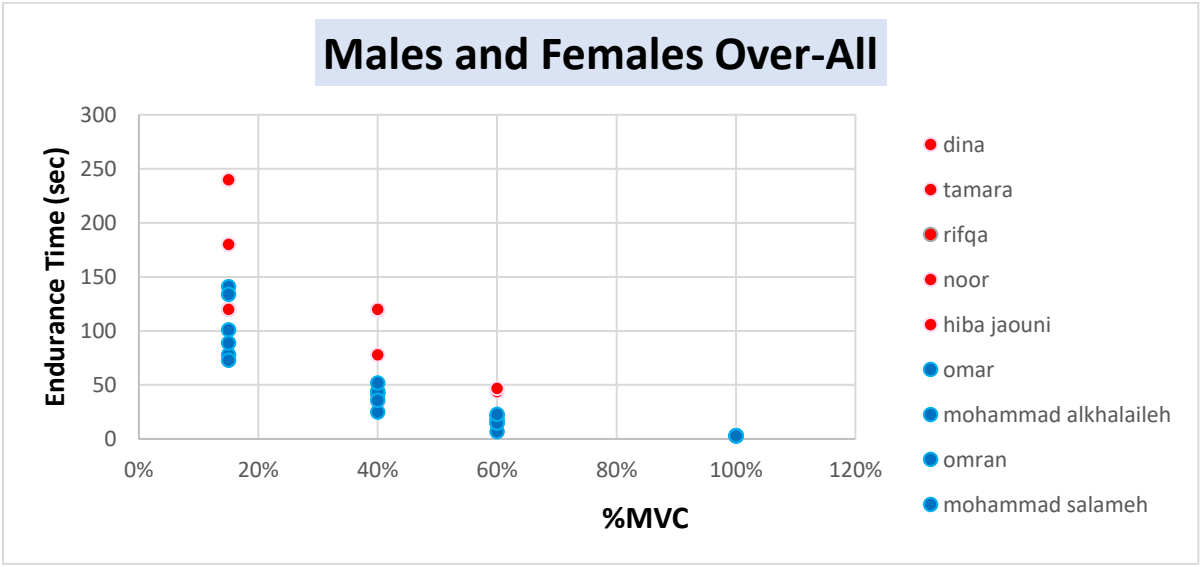


*Figure2: Scattered diagram for the Over-all data in all percentages*

- As the percentage of the MVC taken increases, the time endurance must decrease proportionally. WE NOTE THAT: some participants lacked accuracy during the measurement due to personal reasons, such as getting bored, or it may be caused by the increased enthusiasm of the class.
- Males Notes:

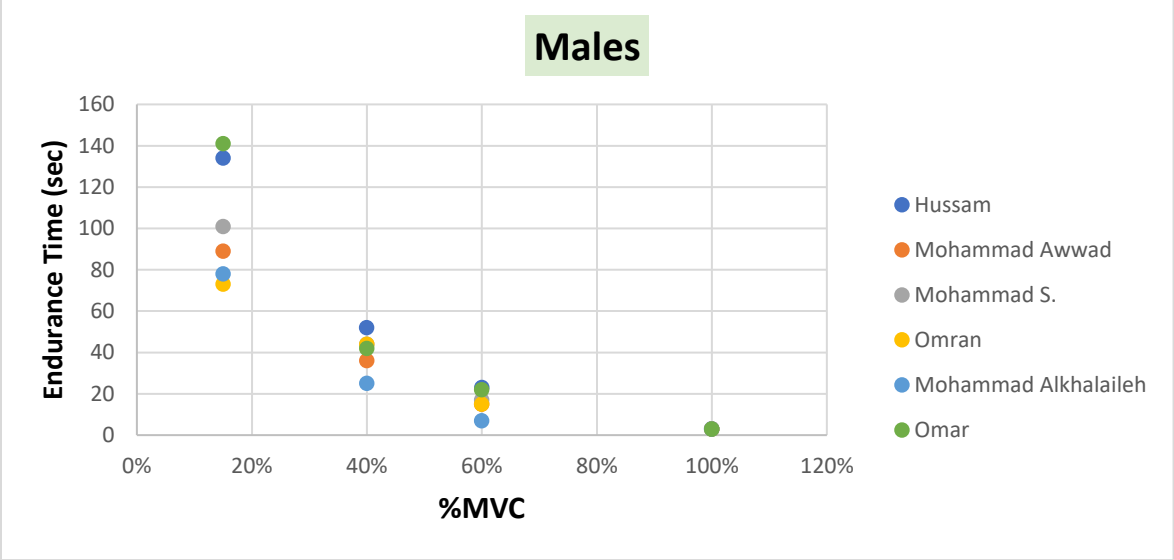


*Figure3: Scattered diagram Males data in all percentages*

We notice that in the 60% & 40% MVC, Hussam had the maximum score of 23 and 52 kg respectively, while Mohammad Alkhalaileh had the minimum values of 7 and 25 kg.

On the other hand, we see that Omar Aljundy had the maximum score in the 15% MVC endurance while Omran had the lowest value of 74 kg.

We can see that on average, Hussam had the largest stamina and endurance time for all percentages except for the 15%, we see that he was slightly below the largest value, this can be explained by that he just wanted to go home, in the same time we see that Omar had one of the largest values in the sample due to his increased enthusiasm in the experiment and willing to score the highest score, ***also one of the most important reasons why he had the maximum value during the 15% test and beating the score of Hussam is that he actually had a MVC of 38 while hussam was 70, which gives us a fewer 15% and enduring this small portion of kg is much easier.***

Important: from the given data we see that hussam is the only smoker within the group however he almost had the maximum values, this is basically since he's used to join motor bike competitions, therefore his wrist muscles are more conditioned to these types of stresses.

- Females Notes:

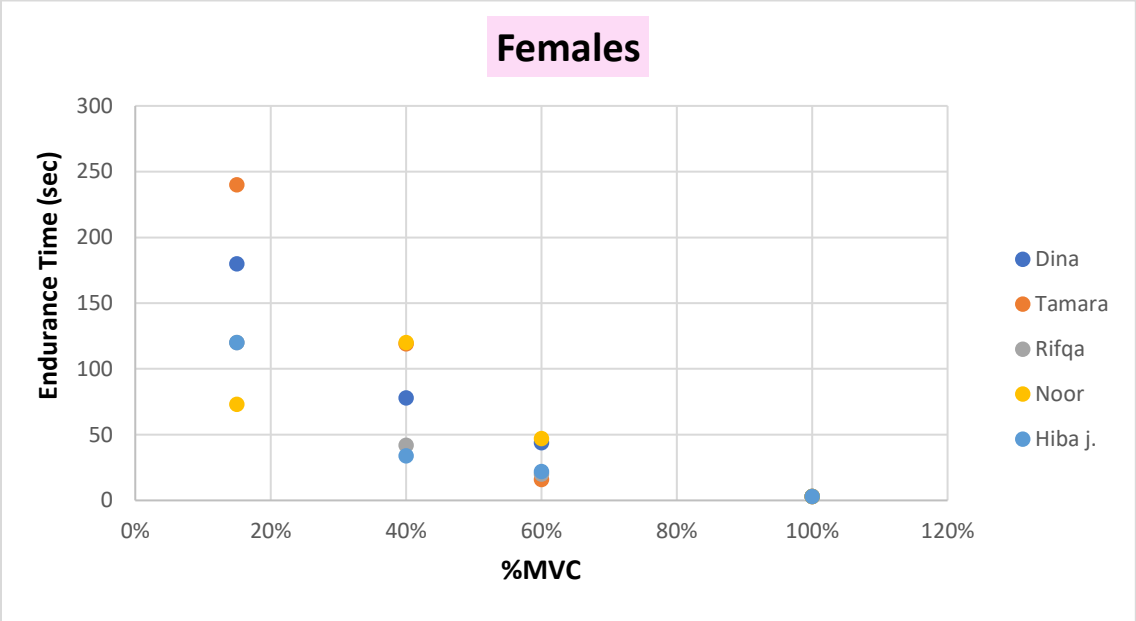


*Figure4: Scattered diagram for Females in all percentages*

From the attached figure, we can see that for the 60% MVC score, Noor had the highest endurance value of 47 kg while Tamara had the lowest value of 16 kg.
We also noticed that Noor also had the maximum value of 120 kg in the 40% MVC, however she had the lowest value in the 15%; ***this is basically due to one of two reasons***:
(1) she just got bored, Noor was a visitor in our lab and didn't take the whole experiment seriously, she didn't had a large MVC (only 16 kg ) so we can't really say that she couldn't endure the 15% of MVC.
(2) the second proposed reason might be that she just got fatigue while doing the experiment due to fasting in Ramadan, not all people can keep their stamina in this kind of experiments especially during noon.
For the other values, Hiba Jaouni had the lowest value during the 40% MVC and Tamara had the largest value during the 15% MVC test, and we can figure out why Tamara had this outstanding score, this is due to the fact that she had the minimum value of the MVC in full strength with a 14 kg, by taking the 15% of it we can see that the smaller the value, the longer someone can withstand certain stress.
IMPORTANT: as clearly shown, that data of 40% and 15% for Hiba Shawabkeh are not completed, this is mainly because Hiba was the one responsible for taking female's measurement, and she just participated in the last part of the experiment, took the full strength of MVC and the 60% of it respectively without a break, so while we're trying to take the 40% measure she got fatigue and couldn't continue the measurements.
From an analytical perspective, we saw that the best course of action was to take her measurements out of the analysis and make a clear comment regarding this decision.

## *Errors*

1) Sitting inappropriately

2) Choosing the wrong seat

3) Holding the device incorrectly

4) Not taking enough rests between trials

5) Hand perspiration

6) Improper stopwatch

7) Device reading and device problems (which could be due to improper calibration), or a competitive attitude.

## *Results*

The main idea that we conclude from our analysis is that gender does highly affect the endurance limits; through which we see that woman can sustain exerting a specific force much longer than any male, this is basically because: 1) Women have longer fibers than men in general and 2) Pregnancy; which can be classified as an intensive activity that women are capable to withstand for a whole 9 months.

Males often have higher MVC, but women are better adapted to endurance-based sports and recover from them more quickly. This is because women have longer muscle fibers, which may explain why men are stronger and more physically powerful.