bmi journal
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Revista de la Sociedad Española de Cirugía de Obesidad y Metabólica
y de la Sociedad Española para el Estudio de la Obesidad
"Bariátrica & Metabólica Ibero-Americana"

# Grip strength predicts the risk of hyperglycemia, hypertriglyceridemia, and elevated systolic blood pressure (SBP) in women

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**DOI: https://doi.org/10.53435/funj.00861**

Received (first version): 16-December-2021 Accepted: April-2022 Accepted: April-2022

## Abstract:

We measured the value of handgrip strength (HG) and its relationship with indicators of metabolic disturbance in a sample of women from the general population attending a nutrition consultation. Data were collected from 491 women aged 18-88 years during 2017-19. Body composition was determined by a tetrapolar, segmental and multifrequency bioimpedance analyser, grip strength value with a hand-held dynamometer, height with a stadiometer, routine blood tests were requested with haemocytometer and biochemistry profile including blood glucose, lipid profile and thyroid profile, and blood pressure was measured with an automatic sphygmomanometer. The sample was stratified into quartiles according to dominant hand grip strength (HGd) and body mass index (BMI).

We found that hand-grip strength is a good predictor of metabolic disturbance independently of BMI. The higher the HGd, the lower the risk of hyperglycemia, hypertriglyceridemia and systolic HT. The study allows us to identify those women who can benefit most from a specific physical exercise programme.

Keywords:

- Handgrip strength
- Exercise
- Hyperglycaemia
- Hipertrigliceridemia
- Blood pressure

## Introduction

Grip strength is a good indicator of muscle strength in the general population and correlates with good muscle functional status. Several studies have related high values of grip strength (Hand-Grip, HG) with reduced all-cause mortality and increased life expectancy (1). HG may be measured with a dynamometer, it is easy to determine and can be used for monitoring in nutritional consultations and to prescribe physical exercise with specific and personalized objectives. Increasing grip strength (Hand-Grip, HG) can help to achieve an improvement in the general health status of the population (2). We tested this hypothesis by applying a standardized protocol in a nutrition clinic to study the links of grip strength to biological parameters and several of the most common indicators of metabolic disease. Studies by other authors report the improvement of biochemical parameters such as glucose or blood lipids with the practice of physical exercise (3). A simple way of monitoring fitness or setting exercise goals can be achieved by using HG as an indicator.

The main objective of this work was to study the dominant hand grip strength (HGd) value of a sample of women and its relationship with body composition, analytical-metabolic indicators and blood pressures and to validate a standardized protocol for application in a nutrition clinic to establish specific recommendations for physical exercise and nutritional monitoring.

## Materials and methods

491 women were studied between 2017 and 2019, in which the HGd value (Kg) was determined using a handheld dynamometer (CAMRY EH101), body composition with a bioimpedance analyser, tetrapolar, segmental and multifrequency (TANITA MC780MA), height with a stadiometer (LEICESTER TANITA HR001), routine analytical tests (haemocytometer and biochemistry including glycaemia, lipid profile and thyroid profile); and blood pressures were measured with an automatic blood pressure monitor (OMRON EMH907). Quartiles for HGd of strength in kilograms were determined by statistical procedure with rounding adjustment (HGd, Q1: < 22.4; Q2: 22.5 - 25.4; Q3: 25.5 - 28.9; Q4: >29). Women were classified into BMI quartiles according to SEEDO criteria (Q1: <20.0 - 24.99; Q2: 25.00 - 29.99; Q3: 30.03 - 34.89; Q4: >35.05). Differences between quartiles were analyzed by ANOVA, using Microsoft Excel as data aggregator and GraphPadPrism 8 as statistical and graphing software.

We considered the criteria for hyperglycemia with baseline glycaemia ≥95mg/dL; for hypertriglyceridemia TG ≥150mg/dL and for elevated blood pressure TAS ≥140mmHG.

Relative risk (RR) was determined using the formula:

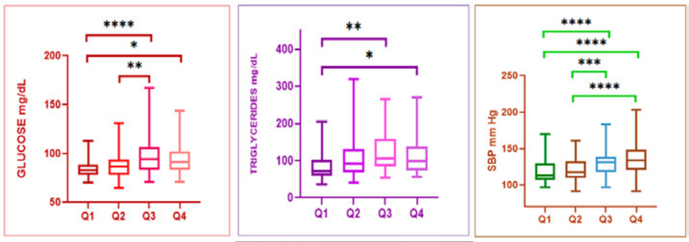
$$RR = {}^{a/(a+b)}\big/_{(c/(c+d))}$$

Where: a; subjects in Q with altered parameter, b; all with altered parameter, c; subjects in Q and d; all subjects.

Applying the following results criteria; RR=1 indicates there is no association between the presence of the risk factor and the event, RR>1 indicates there is a positive association, that is, the presence of the risk factor is associated with a higher frequency of the event, RR<1 indicates there is a negative association, that is, there is no risk factor, what exists is a protective factor of metabolic alteration according to the quartiles of HGd and BMI. Significant differences were considered according to the conventional criterion of p≤0.05.

## Results

As expected the BMI value is associated with significant elevations in baseline blood glucose, triglycerides (TG) and systolic blood pressure (SBP, Figure 1).




| CUARTILES DE BMI | ANOVA |
|---|---|
| *GLUCOSE* | p=<0.0001**** |
| *TRIGLYCERIDES* | P=0.0037** |
| *SBP* | p=<0.0001**** |

*Figure 1.Box&whiskersplots of values for Basal Glycaemia, Triglycerides and Systolic Blood Pressure in BMI quartiles. Median +/- Range. ANOVA.*
**=p<0.05; **=p<0.01; ***=p<0.001, ****=p<0.0001*

RR values for BMI indicate that the highest quartile (Q4) relative to the lowest BMI (Q1) implies a 3-fold increased risk of hyperglycaemia and a 4-fold increased risk of elevated SBP, but no difference in the risk of hypertriglyceridemia (Table 1) in women in the general population.

| GLUCOSE | | | | |
|---|---|---|---|---|
| | Q1 | Q2 | Q3 | Q4 |
| RR | 0.45 | 0.60 | 1.57 | 1.40 |
| N=261 | 46 | 76 | 77 | 62 |
| MEDIANA | 83 | 87 | 94 | 91 |
| RI | 11 | 16 | 21.75 | 17.75 |
| TRIGLYCERIDES | | | | |
| | Q1 | Q2 | Q3 | Q4 |
| RR | 0.90 | 0.46 | 1.61 | 1.09 |
| N=233 | 46 | 69 | 66 | 52 |
| MEDIANA | 73 | 92.50 | 105.50 | 98 |
| RI | 40.25 | 60.50 | 73.25 | 61.75 |
| SYSTOLIC BLOOD PRESSURE (SBP) | | | | |
| | Q1 | Q2 | Q3 | Q4 |
| RR | 0.5 | 0.65 | 1.04 | 2.11 |
| N=491 | 89 | 164 | 135 | 103 |
| MEDIANA | 113 | 118 | 131 | 138 |
| RI | 21 | 22.5 | 20.50 | 26.5 |

*Table 1. BMI-RR quartile values (from < BMI to >)*

On the other hand, increased strength (HGd) has a protective effect on hyperglycemia (Figure 2).

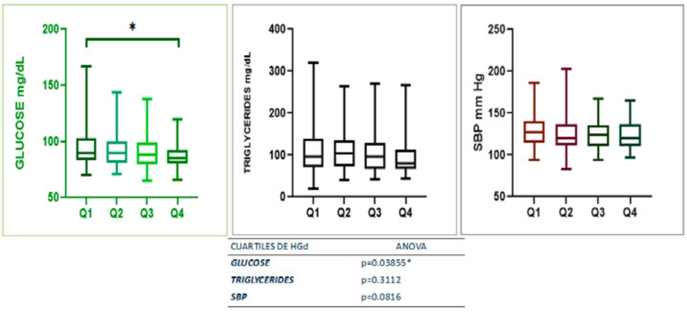



*Figura 2.Box&wiskers plotsof values for Basal Glycaemia, Triglycerides and Systolic Blood Pressure in HGd quartiles. Median +/- Range. ANOVA.*
**=p<0.05; **=p<0.01; ***=p<0.001, ****=p<0.0001*

Considering the RR in the highest strength quartile relative to the lowest, the relative risk for elevated TAS and hypertriglyceridemia is halved and the risk for hyperglycemia is reduced by one third, regardless of BMI value (Table 2).

| GLUCOSE | | | | |
|---|---|---|---|---|
| | Q1 | Q2 | Q3 | Q4 |
| RR | 1.23 | 1.25 | 1.04 | 0.44 |
| N=276 | 75 | 71 | 68 | 62 |
| MEDIANA | 89.50 | 90 | 88 | 85 |
| RI | 20 | 19 | 18 | 12 |
| TRIGLICERIDES | | | | |
| | Q1 | Q2 | Q3 | Q4 |
| RR | 1.28 | 1.28 | 1.04 | 0.69 |
| N=241 | 63 | 59 | 59 | 60 |
| MEDIANA | 95 | 103.50 | 95 | 79 |
| RI | 66 | 62 | 57 | 44.50 |
| SYSTOLIC BLOOD PRESSURE (SBP) | | | | |
| | Q1 | Q2 | Q3 | Q4 |
| RR | 1.71 | 0.77 | 0.88 | 0.88 |
| N=491 | 134 | 103 | 132 | 122 |
| MEDIANA | 126.50 | 98 | 124 | 120 |
| RI | 26.25 | 25 | 25.25 | 26 |

*Table 2. BMI-RR quartile values (from < HGd to >)*

## Discussion

The main determinant of reduced grip strength is age. In fact, for the same age, higher HGd values predict longer life expectancy and better overall functional status independently of other factors (4). Therefore, improving grip strength per se should be a general population health goal, especially in relation to age.

There are very few studies on HG as an independent predictor related to obesity and metabolic disease, and even fewer if we refer specifically to women. Our study group is restricted to women from the general population, of all ages and conditions and without any special degree of training. This group was studied in a routine nutrition practice. In this case, and expected because previously described, the BMI score determines higher risk of metabolic disease in general, independently of age.

We further found that routinely measured HG values may be predictive of metabolic disease independently of BMI. This is of great interest because BMI does not yield a good approximation of body composition. In this sense the HG value is indicative of muscle functional capacity, which is even more interesting than determining muscle mass. In this study we do not show data of body composition that we have obtained in this cohort, but still the isolated HGd value is useful enough.

Although no significant differences were found between the means of quartiles for triglycerides or TAS, the study of the RR of any of the three parameters studied individually and as a whole shows that the higher the HGd, the lower the risk of metabolic alteration. In the case of basal glucose, this is significantly lower and correlates inversely with hand-grip strength (HGd), which confirms that this parameter is independent of BMI and a good indicator of the functional state of the muscle. The effect of muscle strength on glycaemia was previously described (5), and our results consolidate this finding in untrained women. In addition, in our study the relative risk of elevated systolic blood pressure is much higher in women with very small strength (Q1).

On the other hand, the risk of hypertriglyceridemia does not seem to be influenced by grip strength, as the incidence is similar in all groups.

Finally, the protocol we have applied to the patients is simple, inexpensive, it is not time consuming and can provide complementary information that allows us to personalize health recommendations, and to identify those women who will obtain the greatest benefit from developing a specific physical exercise programme for strength.

## Conclusions

The HG value is a BMI-independent predictor of metabolic disturbance, and the higher the hand grip strength (HG), the lower the risk of hyperglycemia, hypertriglyceridemia and elevated TAS in women. The HGd value can complement the BMI, providing an assessment of muscular functional status in women, allowing us to identify those who can benefit most from a personalize physical exercise programme.

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