

Original Article

Association of grip strength with obesity & cortisol; Possible indicators of biological ageing.

Faizan Mirza^{1,2}, Amaila Fazal¹, Khadija Shabbir^{1,2},
Hafsa Farooq^{1,2} & Sadaf Ahmed^{1,2,3} 

¹Department of Physiology, University of Karachi

²Psychophysiology Research Lab, MAHQ Biological Research Centre,
University of Karachi

³Advance Educational Institute and Research Centre



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Corresponding Author Email:

fm.faizan.mirza@gmail.com

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Abstract

Background: Cortisol has a positive correlation with obesity, which indicates a relation between obesity and cortisol. Furthermore, there are increased chances of demolished muscle strength up to two times with elevated levels of cortisol. Thus, the aim of the study was to assess the impact of increased cortisol levels on the grip strength and to determine that the grip strength is a possible indicator for accelerated biological ageing.

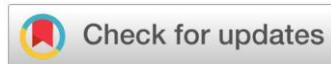
Methodology: This cross-sectional, purposive sampling study was conducted in Karachi, Pakistan. Overall 412 were recruited to participate in the study, the data for age, gender, BMI, grip strength, and cortisol was collected from the participants. The age-wise correlates of hand grip strength were assessed using Multiple linear regression analysis and the mean decline in the grip strength with advancing age is displayed.

Results: The mean grip strength of the overall population was 30.75 ± 14.35 . It was observed that there was a negative significant correlation between the age and the grip strength ($F = 3.57$; $r = -0.27$; $p = 0.007$) i.e. with increasing age a gradual decrease in the grip strength was observed. BMI (Obesity) was also significantly associated with grip strength ($p = 0.000$). Moreover, females were more likely to have weak muscle strength as compared to males ($p = 0.000$). However, no significant association was observed among the grip strength, socioeconomic status & longevity in any of the studied age groups ($p > 0.05$). While a significant correlation was found between grip strength and obesity as well as between obesity and cortisol.

Conclusion: Thus it can be concluded that obese individuals had increased chances of accelerated biological ageing due to an increase in cortisol, and a weakened grip strength is an indicator of it.

Keywords

Ageing, Grip Strength, Cortisol, Obesity, Socioeconomic Status, Longevity.



Introduction

Physical fitness is an important parameter for a healthy life, which is generally lost in old age, especially the loss of muscle strength^{1, 2}. A useful way to estimate physical fitness and physical well-being is the determination of grip strength, which is increasingly used as an indicator of overall muscle strength and function^{3, 4}. Several studies have shown that poor grip strength predicts increased all-cause mortality in older people^{5, 6}. A study was done on the population of healthy men of middle age, and their grip strength was measured to predict long term death risk, suggests that all the influences that affect muscle function and size earlier in life might be important⁷.

Lower grip strength has also been found associated with higher levels of insulin in fasting, in both cross-sectional and longitudinal studies, this suggests that muscle weakness may precede the development of insulin resistance^{8, 9}. A drastic rise in cortisol level is also observed postprandial. Increased food intake also causes an increase in cortisol and Adrenocorticotrophic hormone (ACTH) level, noted in females who were exposed to visceral obesity. Thus, there is a positive correlation between cortisol and BMI which indicates a relation between obesity and cortisol¹⁰. And it is a well-established fact that with growing age, grip strength decreases¹¹, whereas grip strength is also associated with height and body weight¹².

Thus, muscle might enhance their volume and along with the bluntness in the production of protein through the vast action of cortisol¹³. Moreover, fluctuations in the volume of the muscles in the elderly have been related to the standard level of cortisol. Chronic stimulation of cortisol has been associated with undesirable outcomes of muscle strength¹⁴. Increased chances of demolished muscle strength up to two times have been observed with elevated cortisol concentrations¹⁵.

Under physiological circumstances, ageing causes an increase in cortisol level; this rise in cortisol levels may lead to defects in the systems of the body, and slowly deteriorates the immune system.

Along with the process of ageing, there is a loss of restoration in response to stress, which can cause damage to various organs of the body. On the other hand, ageing also has a blunted effect on regulation and homeostasis of the HPA axis. ACTH adrenal axis is modified according to age with the presence of stress. Increased cortisol level in comparison to the normal level for a longer period of time leads to deterioration of healthy body cells, dampens synaptic activity, decreases neuroplasticity and decreases in the longevity of the cells of the hippocampus. Elevated serum cortisol leads to the destruction of muscles, skeletal system, cognitive functions, increases, android obesity and thus, the quality of life is compromised¹⁶. Thereby, the aim of the study was to assess the impact of increased cortisol levels & BMI on the grip strength and to determine that the grip strength is the possible indicator for accelerated biological ageing.

Methodology

This study was approved by the Pakistan Medical Association Committee on Ethics (Reference Number: QR/957/NMC/10). This cross-sectional study was carried out in Karachi, Pakistan, from August 2019 till January 2020. Overall 412 were recruited to participate in the study, including both males and females of age groups between 20 to 69 years through purposive sampling. Written informed consent was obtained from each participant, prior to enrollment. The data for age, gender, BMI, grip strength, and cortisol levels was collected from the participants. Subjects having any pathological condition were excluded from this study.

The BMI of the participants was calculated using the formula: $BMI = \frac{kg}{m^2}$ BMI and the cutoff values were used as per the World Health Organization (WHO) guidelines. However, to measure the Grip strength electronic hand dynamometer, EH101 was used, and the cortisol levels were measured quantitatively by the immunoassay method.

For assessment of grip strength in association with demographic characteristics, Chi-square test was

used and p -value < 0.05 was considered significant. The age-wise correlates of hand grip strength were assessed using Multiple linear regression analysis and the mean decline in the grip strength with advancing age is displayed and $p < 0.05$ was considered significant.

Result

It was observed that most of the subjects from either age groups had weak grip strength, 37.39% of subjects with 20 to 29 years of age, 24.36% from 30 to 39 years, 19.32% from 40 to 49 years, 10.92% from 50 to 59 years, 7.9% from 60 to 69 years' age group had weak muscle strength ($p < 0.018$). Although there is a varying trend in the significance values but mostly the subjects had either normal or weak muscle strength.

Table 1: Hand-grip strength by study demographics (n=412)

Variables	Sub-categories	Grip Strength			p-value
		Weak (N=238)	Normal (N=126)	Strong (N=48)	
Gender	Male	109	95	35	0.000*
	Female	129	31	13	
Age (Years)	20 to 29	89	44	11	0.018*
	30 to 39	58	47	11	
	40 to 49	46	19	17	
	50 to 59	26	10	7	
	60 to 69	19	6	2	
Socioeconomic Status (SES)	Middle SES	67	27	10	0.205
	Upper Middle SES	102	56	22	
	Low SES	50	35	14	
	Upper SES	7	8	0	
Marital Status	Single	116	75	14	0.001*
	Married	122	51	34	
Obesity	Underweight	46	28	7	0.000*
	Normal	168	47	24	
	Overweight	24	51	17	
Cortisol	Low	6	5	0	0.235
	Normal	217	113	48	
	High	15	8	0	
Longevity	Present	167	115	29	0.000*
	Absent	71	11	19	

* $p < 0.05$ is considered statistically significant.

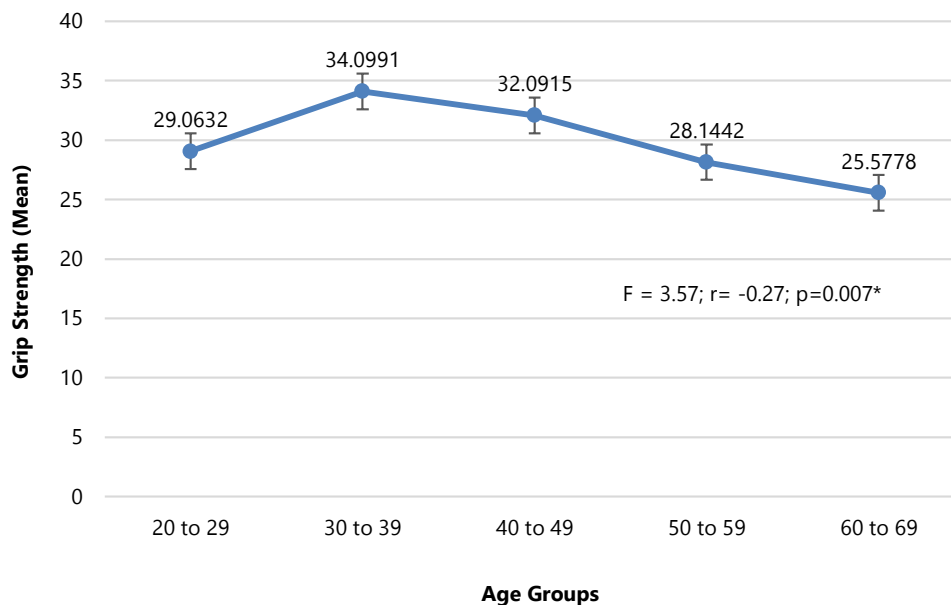


Figure 1: Shows the age-wise decline in the association of grip strength among the study subjects

Table 2: Age-wise correlates of hand-grip strength

Age Groups	Beta coefficient	95% CI	p-value
20 to 29 years	0.15	-0.08, 1.69	0.076
30 to 39 years	0.03	-0.72, 1.06	0.706
40 to 49 years	-0.22	-1.14, -0.08	0.024*
50 to 59 years	-0.20	-0.47, -0.01	0.043*
60 to 69 years	-0.32	-0.42, -0.10	0.001*

*CI = confidence interval

*p<0.05 is considered statistically significant

It was noted that there was a linear rise in cortisol level among subjects as age increased. In age group 20-29 mean Cortisol level was found to be 20.14 ± 3.78 compared to 20.83 ± 4.81 in age group 60-69 as shown in Figure 2.

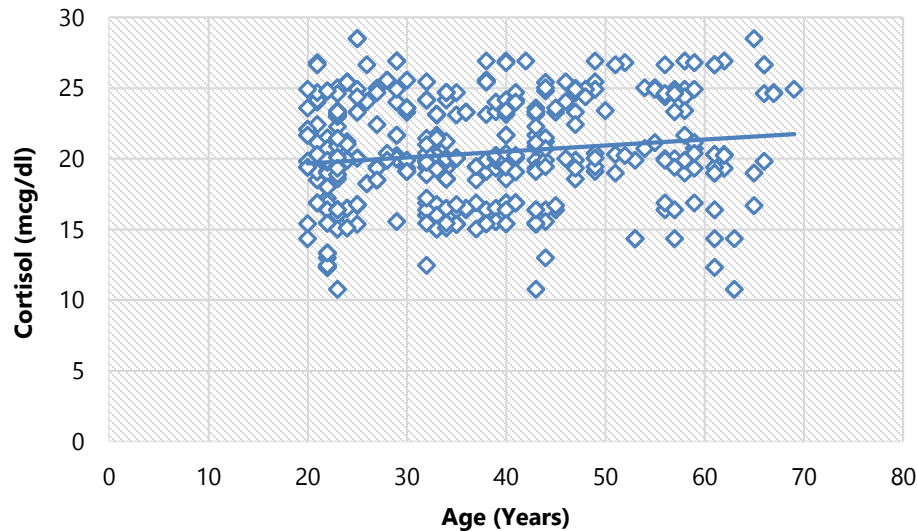


Figure 2: Shows the age-wise rise in cortisol among the study subjects

A significant relationship was found between obesity and cortisol.

Table 3: Comparison of Obesity & Cortisol (n=412)

Obesity	Cortisol Levels			p-value
	Low	Normal	High	
Underweight	3	78	0	0.045*
Normal	8	216	15	
Overweight	0	84	8	

*p<0.05 is considered statistically significant

Discussion

Physical fitness is an important parameter for a healthy life, which is generally lost in old age, especially the loss of muscle strength^{1,2}. A useful way to estimate physical fitness and physical well-being is the determination of grip strength, which is increasingly used as an indicator of overall muscle strength and function^{3,4}. Increased chances of demolished muscle strength up to two times have been observed with elevated cortisol concentrations¹⁵. And it is a well-established fact that with growing age, grip strength decreases¹¹, whereas grip strength is also associated with height and body weight¹². Thereby, this study was conducted to assess the impact of increased cortisol levels on the grip strength and to determine that the grip strength is the possible indicator for accelerated biological ageing.

A total of 412 subjects were enrolled, and of them, 239 were males & 173 were females with a mean age of 29.84 ± 11.550 years. Of these, the cortisol levels of only 100 participants were assessed, and it was found that 59 subjects with normal cortisol levels had weak grip strength while only 5 with high cortisol ($p=0.000$). This is due to the fact that muscles might enhance their volume and along with the bluntness in the production of protein through the vast action of cortisol¹³. Moreover, fluctuations in the volume of the muscles in the elderly have been related to the standard level of cortisol. However, chronic stimulation of cortisol has been associated with undesirable outcomes of muscle strength¹⁴. And could increase the chances of demolished muscle strength up to two times with elevated cortisol concentrations¹⁵.

When the association between the grip strength and age was analyzed, it was found that there was a gradual decrease in the grip strength with increasing age. The mean grip strength among the age group of 20 to 29 years was 31.26, while 25.3 among those of 60 to 69 years of age. This is in agreement with other studies. Several studies have shown that poor grip strength predicts increased all-cause mortality in older people^{5,17-21}. The underlying mechanisms are poorly understood. Furthermore, muscle strength is known to decline with age, accompanied by a loss of muscle mass and an increase in fat^{22,23}.

Moreover, it was also found that the Body Mass Index (BMI), an indicator of obesity was also significantly associated with grip strength ($p=0.039$). This is due to the fact that poorer grip strength has been associated with higher fasting insulin levels, both cross-sectionally and longitudinally, it seems likely that muscle weakness may precede the development of insulin resistance^{24, 25}. Some evidence exists that poor strength precedes the development of insulin resistance and predicts diabetes²⁴.

Furthermore, it was also found that females were more likely to have weak muscle strength as compared to males ($p=0.001$). This finding is also similar to the previous researches. The investigators have found a sex difference in grip strength; men have more powerful handgrips than women^{11, 26, 27}.

Research findings in a population of healthy men also determine that grip strength measured in middle age predicts long-term risk of death suggest that influences affecting muscle size and function earlier in life may be important²⁸. Our findings are in agreement with this research as the mean Grip strength of the overall population was 31.39 ± 12.10 , i.e. 109 subjects had weak muscle strength, 191 had normal & only eight subjects had strong muscle strength. It was observed that most of the subjects from either age groups had weak grip strength, 70.6% of 20 to 29 years subjects had weak muscle strength, and there was a positive association between the two variables ($p < 0.001$).

Although there is a varying trend in the significance values, but mostly the subjects had either normal or weak muscle strength.

Thus, middle-aged people, poor muscle strength has been found to be associated with lower body weight²⁹, presence of chronic diseases³⁰, and physical inactivity³¹. In addition, mid-life strength may be modified by earlier lifestyle characteristics, such as exercise habits; other factors such as type of work; or early life diseases that have been cured but have had a negative effect on strength^{31, 32}. Some evidence exists that poor strength precedes the development of insulin resistance and predicts diabetes²⁴. Thereby, good muscle strength has been found to protect older people from disability, independent of chronic diseases³¹. And strong grip strength is associated with physical activity, which in itself predicts better survival³³.

A greater abdominal fat have been linked with hyper responsiveness towards HPA axis in most studies, however few studies have shown unresponsiveness for the same³⁴. The current study showed a significant relationship between Obesity and Cortisol level with p value being 0.04. In women there is an impaired metabolism of cortisol from 5β reductase enzyme while in men there is an increased conversion of cortisone to cortisol by 11β reductase, that leads to impaired cortisol clearance in obese individuals, which possibly explains the over activation of HPA axis in relation to obesity³⁵, although the mechanism involved stays unclear³⁶.

Conclusion

Thus, it was concluded that as the grip strength was decreasing with an increase in obesity, thereby, obese individuals have increased chances of accelerated biological ageing, and weak grip strength and high cortisol baseline levels are an indicator of it. However, future studies are recommended to be conducted on the factors that lead to reduced grip strength and increased cortisol in obese individuals and its relation to chronic disease patients. Additionally, grip strength and cortisol levels could also be assessed in association with the body fat

representation more deeply for the mutual interconnection of variables related to anthropometry.

Conflicts of Interest

The authors declare that there is no conflict of interest regarding the publication of this study.

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