

STUDY OF EFFECTS OF VIBRATION ON GRIP STRENGTH

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Introduction

Hand Arm Vibration Syndrome (HAVS) - A collective term that includes a number of disease patterns involving the vascular, neurological and musculoskeletal systems. These disease patterns are associated with exposure to hand-arm vibration and are experienced in particular in the hands and forearms of the exposed worker.

Carpal Tunnel Syndrome (CTS) - Carpal tunnel syndrome is a condition caused by compression of the median nerve within the carpal tunnel at the wrist. CTS is characterised by numbness, tingling, burning, or pain in the thumb, index, and middle fingers. Significant exposure to hand-arm vibration – Employees whose exposure to hand-arm vibration represents a risk to their health as determined by a risk assessment. This means:

- 1) All workers regularly exposed to hand-arm vibration above the action level of 2.5 m/s².
- 2) Workers who are only occasionally exposed above the action level but a risk assessment or other factors indicate that the pattern of exposure may pose a risk to health, for example:
 - a. Use of specific tools or in specific jobs where a detailed risk assessment shows greater than 2.0 m/s².
 - b. Pragmatic, based on combination of risk assessment, knowledge of tools and uncertainty regarding the frequency or duration of exposure,
 - c. Any job where the worker experiences numbness or tingling in fingers after 5-10 minutes of continuous use of tool,
 - d. Jobs where a claims history indicates that HAVS may be a problem.

As Vibration exposure is difficult to assess directly using many fast Fourier (FFT) spectral analyzers because of long task cycle times. Exposure time can-not be accurately estimated using time standards because of high variability between operators and work methods. It is difficult to record vibration without interfering with the operation. Alternately, it is divided into Hand-arm vibration (HAV), affecting workers who use all manner of vibrating pneumatic, electrical. Hydraulic and gasoline powered hand held tools. Due to the weight of the tool and awkward positions that a hand tool operator has to adapt to sometimes, he/she is forced to let the tool rest against his/her torso in an attempt to make the task more comfortable and also to damp the vibration. This results in vibration being transmitted to the body through hand-arm system.

Methodology

For this project a experimental setup is made for identifying and measuring the grip exertion before work while working and after the work of vibration. For this The participants taken were 40 unpaid volunteers (20 men and 20 women) with varied backgrounds in manual work. Participants were not recruited based on their history of work in any particular industry or history of performing specific work tasks. All were in good health at the time of the study, and no participants had acute or chronic musculoskeletal injuries to their upper extremities. Each provided written informed consent before participation. Some of the participants were right handed that is their right had been dominant and some were of left handed that is their left hand is dominant and other non dominant. Different variables are independent and dependent.

Independent variable are

- Vibration level i.e cycles per second and amplitude.
- Dominant and non dominant.
- Male and female participants.
- Peak Grip force in Kgf.
- Average of two values i.e I Maximum voluntary exertion and II Maximum voluntary exertion.

Dependent variables are-

1. effect on grip strength, Kg f
2. Other symptoms

Experimental setup

A vibrator of around 2500-3500cycles per min is developed for this experiment using mechanical attachment attached to a single phase brushed motor of rating 3500rpm make Volco. The vibration is given by connecting rod connected offset to the motor, and is given to the pvc handle attached on the top of the box. This box is connected to a electronic circuit which calculate the voltage , frequency . this experiment is designed for single minute and for more time it can be adjusted as required. For experiment subject is told to hold the vibratory handle and it is started in timer mode. After one minute he machine automatically stops and frequency is displayed on the screen provided. As due to the force exerted by the subjects the frequency changes

for every person so it can't be fixed as per the rating. For this reason the same as been provided in the machine.

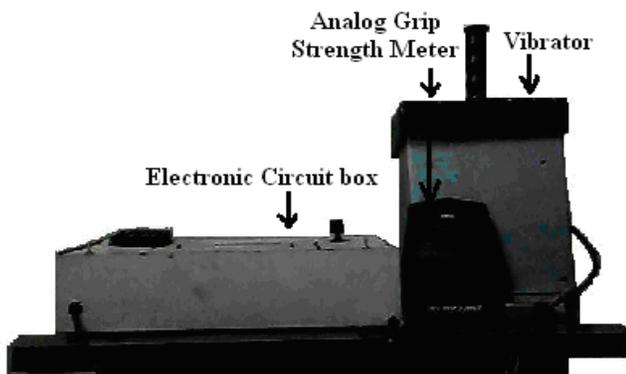
Experimental Task

Participants / Subjects

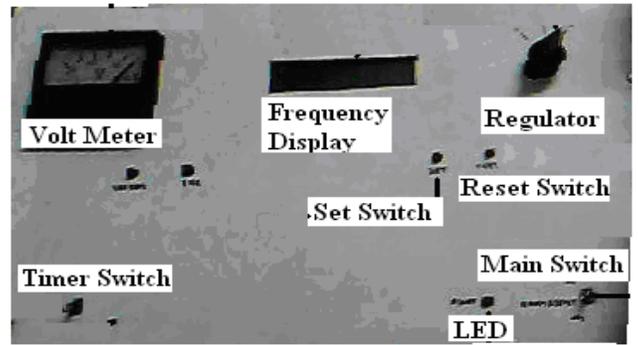
To study the influence of segmental vibration on the workers, 20 participants were taken among them 10 are males and 10 are females . Each participant was in good health and no participant had acute or chronic musculoskeletal injuries to their upper extremities. during the experiment and had their breakfast during the experiment. participants were not recruited based on their history of work in any particular industry or history of performing specific work task. Grip strength were measured before the experiment, after one minute of vibration then after 3 minutes of vibration and after 5 minutes of vibration. Anthropometric data taken of the subjects is given further. First the subject is told to take some breakfast and then the experiment is started.

1. Grip strength is recorded using the analog grip strength meter.
2. Subject is told to sit on the chair and hold the vibrator machine handle.
3. The machine is set in timer mode and is started.
4. After one minute it stops automatically and frequency is displayed on the screen and again the grip strength is taken. The same is noted down,
5. subject is told to get ready for next minute reading.
6. This same procedure is repeated for three minute and five minute and the record is noted in the table.

Experimental setup



GRIP STRENGTH DYNAMOMETER



Electronic circuit box

Anthropometric data

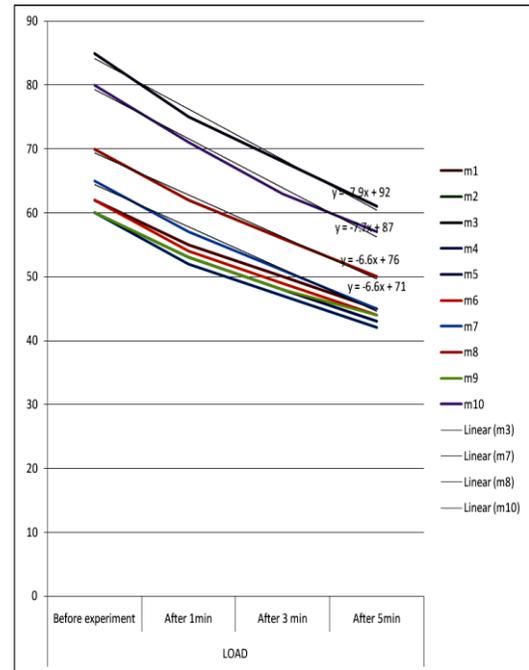
S.no	Age	Sex	Weight	Height	Hand Circumference		Hand Width		Wrist
					without thumb	with thumb	without thumb	with thumb	
1	30	M	75	165.1	21	25	10.5	11.5	17
2	32	M	65	170.18	20	26	9.5	12	18
3	50	M	65	175.26	22	27	11	13	20
4	52	M	60	167.64	21	24	10	11.5	16
5	48	M	55	175.26	20	23	9.5	10.5	15
6	49	M	80	160.02	22	25	11	12	18
7	40	M	60	167.64	20	23	9	10.5	17
8	32	M	60	154.94	23	27	11	13	19
9	36	M	70	177.8	22	26	10.5	13	17
10	59	M	90	180.34	23	27	13	15	21
11	25	F	50	162.56	18	21	8.5	10	15
12	56	F	85	139.7	19	22	8.5	10	17
13	29	F	80	149.86	20	22	9	11	16
14	20	F	55	134.62	18	21	8.5	10	16
15	29	F	57	162.56	19	21	9.5	12	16
16	48	F	65	177.8	20	22	10	11	15
17	18	F	55	177.8	19	21	9	11	16
18	28	F	60	152.4	18	22	8.5	10	15
19	27	F	62	165.1	20	23	9	12	17
20	19	F	65	167.64	21	20	8	10	16

Results & discussions

Analysis of data for males

s.no	Grip Strength in Kgf			
	Before experiment	After 1min	After 3 min	After 5min
m1	62	55	50	45
m2	70	62	56	50
m3	85	75	68	61
m4	60	52	47	42
m5	60	53	48	43
m6	62	54	49	44
m7	65	57	51	45
m8	70	62	56	50
m9	60	53	48	44
m10	80	71	63	57

General grip strength equation For Male



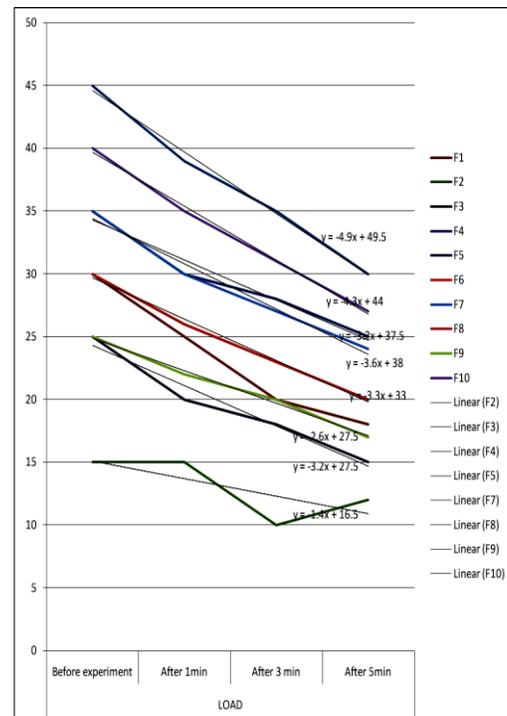
Analysis of data for females

S.no	Grip Strength in Kgf			
	Before experiment	After 1min	After 3 min	After 5min
F1	30	25	20	18
F2	15	15	10	12
F3	25	20	18	15
F4	45	39	35	30
F5	35	30	28	25
F6	30	26	23	20
F7	35	30	27	24
F8	30	26	23	20
F9	25	22	20	17
F10	40	35	31	27

From the analysis we can generate the general line trend Equation for males i.e:

$$Y = - 7.2 x + 81.5$$

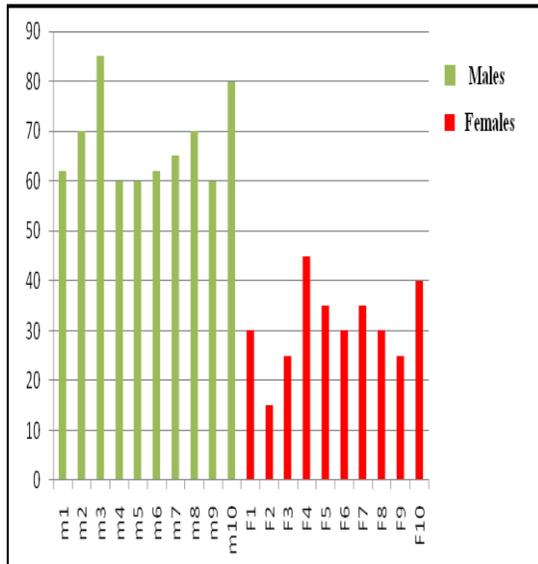
General grip strength equation For Female



From the analysis we can generate the general line trend Equation for females i.e:

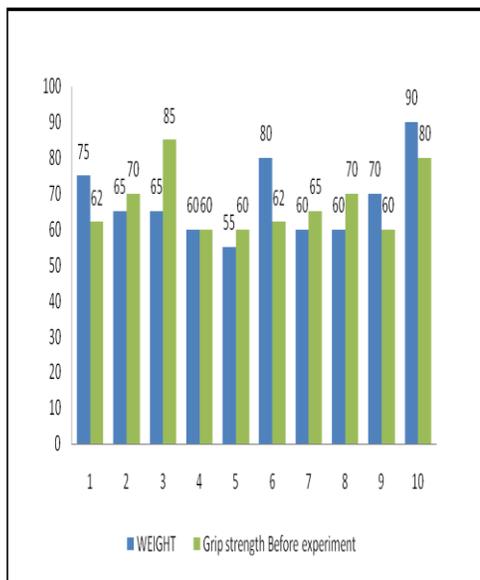
$$Y = - 3.5 x + 36.71$$

Effect of sex on grip strength



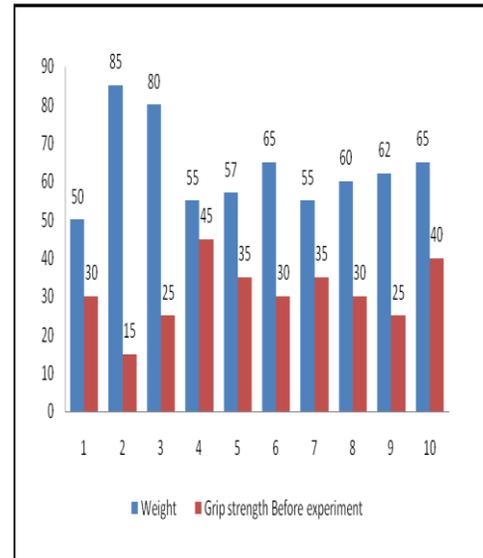
As per the experimented data it is seen that the average grip strength of male is 74 Kgf and that of female is 31 Kgf. This indicates that females have 54% less grip strength than males.

Effect of weight on grip strength for males



For males that their grip strength in general matches with their weight. For different males it can be seen that the value of their grip strength is near to the value of their weight.

Effect of weight on grip strength for females



it can be seen that for overweight females (weight more than 55kg) there is a large difference in their grip strength. Or we can say for overweight females they have very low grip strength value as compare to average weight females. And about the average weight females they show the same trend as males i.e their grip strength value remains nearer to their weight taken in Kg

Standard deviation

Using the formula for standard deviation

$$\sigma_1 = \sqrt{\frac{\sum (Dm - D1m)^2}{n-1}}$$

Between one minute and 3 minute data

for male is 2.06
for female is 1.16

Between three minute and five minute data

for male is 1.95
for female is 1.127

CONCLUSION

(a) General line trend equation for male considering all the trends comes to be

$$Y = - 7.2 X + 81.5$$

- (b) General line trend equation for male considering all the trends comes to be

$$Y = - 3.58 X + 36.71$$

- (c) Females have **54%** less grip strength force than males
- (d) For males that their grip strength in general matches with their weight. For different males it can be seen that the value of their grip strength is near to the value of their weight
- (e) For females it can be seen that for overweight females (weight more than 55kg) there is a large difference in their grip strength. Or we can say for overweight females they have very low grip strength value as compare to average weight females.

And about the average weight females they show the same trend as males i.e their grip strength value remains nearer to their weight taken in Kg

- (f) Between one minute and three minute the standard deviation for male is 2.06
Between three minute and five minute the standard deviation for male is 1.95
Between one minute and three minute the standard deviation for female is 1.16
Between three minute and five minute the standard deviation for female is 1.127
Between three minute and five minute the standard deviation for female is 1.127

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