TECHNICAL UNIVERSITY OF CLUJ-NAPOCA

ACTA TECHNICA NAPOCENSIS

Series: Applied Mathematics, Mechanics, and Engineering
Vol. 67, Issue II, June, 2024

THE INFLUENCE OF EXTRA WEIGHT ON THE PHYSIOLOGICAL PARAMETERS OF THE CIRCULATORY SYSTEM

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Abstract: *This paper is aimed at identifying the influence of additional weights (AW), on the back or hands, on the functioning of the cardiac/circulatory system. Weight, as well as daily activities (going up and down the stairs, running, walking, etc.), have various effects on the function of the cardiac system, as we well know, sensations such as palpitations or hyperventilation. Considering the information above and using a blood pressure monitor and a pulse oximeter it was studied the influences of activities with AW on the functioning of the circulatory system. It was concluded that AW influences vital parameters, such as pulse and blood pressure, depending on the type of activity. The influences appear even in the absence of weight.*

Keywords: *Pulse, Blood Pressure Monitor, Weight, Pulse*

1. INTRODUCTION

Critical research (see Table 1), on April 13, 2023, identified the interest, according to known databases and using specific keywords and formulations, in the determination of the effects of extra weight/load on human physiological parameters.

Table 1.

Search results on Science Direct and Springer

Keywords/ sentence	**Science Direct https://www.sciencedirect.com/ (no. of results)**	**Springer https://link.springer.com/ (no. of results)**
additional weight climbing influence pulse heart	1907	5176
additional load climbing influence heart rate	3334	9075
backpack climbing influence heart rate	210	839
additional load climbing heart rate	4695	10289
the influence of extra weight on the physiological parameters of the circulatory system	3020	5244

It doesn't necessarily mean that all the found papers were oriented in this direction, but they were offered as a solution by their search engines.

As can be seen, numerous papers have been identified that are oriented to search and identify the influences of extra load on physiological parameters such as pulse, heart pressure, temperature, equilibrium, stability, locomotion, and so on. It can be concluded that there is great interest in the study of additional load/weight effects on physiological parameters such as pulse or heart pressure, but not only. [1; 2; 3; 4; 5; 6; 7] There have been identified even protocols to determine the influence of backpack load on physiological variables. [8]

Weight has various effects on the function of the cardiac system, as we well know, sensations such as palpitations or hyperventilation. Our life activities are supposed to climb stairs, run, walk, etc., but if our health isn't well, we encounter problems that can lead to problems. Gaining body weight increases the risk of health problems, such as cardiovascular diseases, heart failure, high blood pressure, myocardial infarction, stroke, diseases of the joints, some types of diabetes, and some types of cancer.

Received: 16.11.23; **Similarities**: 10.06.24: **Reviewed**: 19.06./19.06.24: **Accepted**:24.06.24.

The heart is formed by a muscular wall (the myocardium) that delimits an internal cavity whose volume depends on the muscle's tightening power (contraction) but also its refilling capacity (relaxation-distensibility, elasticity). The contraction of the muscle generates pressure inside the cavity and thus pumps the blood toward the arteries. The direction of blood flow in the heart is imposed by the existence of some valves which under normal conditions let the blood flow in one direction only.

The heart works in two phases that follow each other and repeat throughout life: the filling phase (diastole) - in which the heart sucks in, and takes oxygenated blood from the lungs, followed by the emptying phase (systole), in which the heart contracts and pumps the blood, previously accumulated, to the arteries. With each beat, the heart pumps a certain volume of blood into the arteries. Multiplying this volume by the number of beats per minute (pulse) results in cardiac output, that is, the volume of blood pumped by the heart in one minute to the whole body.

The pulse varies throughout the day. It adapts to the energy needs of the body. Thus, the pulse increases during physical effort, in stressful conditions, after consuming cardiac stimulants (coffee, tobacco, energy drinks, alcohol), or after a meal, and it decreases during sleep.

The pulse measurement tells us the value of the heart rate. This can be within normal limits, low (bradycardia, defined as a value below 60 beats per minute), or increased (tachycardia, defined as a value above 100 beats per minute). According to a study, 203 healthy adults (165 men and 38 women). It was considered their weight, height, and body fat (BF). The last one was calculated according to studies, and all participants were classified as normal (BF < 25% for men and < 32% for women) or obese (BF ≥ 25% for men and ≥ 32% for women). The exercise test was performed according to an incremental protocol using a treadmill system. The protocol consisted of a 1 minute walk, with participants starting at a walking speed of 5 km/h and increasing the height of a treadmill by 2% per minute for each subsequent workload, until the maximum tolerated by symptoms. Heart rate was monitored during the test. Peak HR at the end of the exercise test was 183 ± 15 bpm and HR dropped after 60 seconds of the exercise with 37 ± 12 beats per minute. Hierarchical multiple regression revealed that body fat accounted for 10.4% of post-exercise HR variability. [9]

According to another study, 104 healthy Indian men were assessed for body fat content using body mass index (BMI), bioimpedance, skinfold thickness (SFT), body circumference measurement (BG), waist circumference (WC), and ratio waist-hip ratio (WHR). Maximum aerobic capacity or $VO_{2\ max}$ (the amount-volume- of oxygen your body uses while exercising as hard as you can) for all subjects was determined indirectly from maximal heart rate achieved using an incremental treadmill protocol using the Astrand and Astrand nomogram. $VO_{2\ max}$ (L/min) shows a significant positive correlation with all methods of estimating body fat. $VO_{2\ max}$ (ml/kg/min) shows a significant negative correlation with skinfold thickness. Monitoring body fat content using skinfold thickness could be further studied for its use in the early identification of healthy young Indian men with low aerobic fitness. [10]

Another study presented the opportunity to assess body composition and 24-hour ambulatory BP measurements (AMBP) in 534 adults excluding patients with vasoactive medications. To determine the relative importance of fat mass and fat-free mass on BP levels, BMI was divided into two components, fat mass index (FMI) and lean mass index (LMI). It was hypothesized that LMI also plays a role in BP regulation. The relationship between FMI and LMI was linear in both sexes. The correlation of FMI with LMI was r = 0.51 (95% CI: 0.41 to 0.59) in men and r = 0.63 (95% CI: 0.55 to 0.70) in women. Subjects were classified by median FMI and LMI as having “low FMI and low LMI”, “low FMI and high LMI”, “high FMI and low LMI”, and “high FMI and high LMI”. In conclusion: Both components of BMI, i.e., lean body mass and fat mass, have a positive but only small to moderate association with the daily and 24-h AMBP components. Relatively large muscle mass may not be beneficial for BP regulation. The current European recommendation for moderate-intensity resistance training as an adjunct to aerobic exercise appears to be adequate. [11]

Considering the information above, this paper aims to verify the hypothesis "Climbing the stairs with AW in the hand/back has a directly proportional influence on the pulse and blood pressure." This way it can be seen what effect weight/load has on a healthy body, for example when climbing stairs.

2. EQUIPMENT AND METHOD

There are two basic methods in statistics: numerical and graphical. The graphical method is more suitable than the numerical one for visual identification of the data trend. The numerical method is more objective and precise. Since they complement each other, it is useful to use them in combination.

Since the beginning of statistics, a widely used method of synthesizing information is the graphical representation of data. The visually presented information is much more penetrating to the senses and even to the intellect and usually "a good picture is more useful than a thousand figures".

Equipment used: pulse-oximeter (iMDK model C101A2, accuracy of ± 2%), blood pressure monitor (SANITAS model, accuracy of ± 3 mmHg), which were used on the left hand, and body weight scale (accuracy of ±0,1 kg).

A number of 5 female subjects (age 24, SD 0.63) participated in this study. Weight and height were obtained from the subjects. Body fat (BF) was calculated according to studies using body mass index (BMI), and all participants were classified as normal. When calculating the body mass index, we used the following formula.

$$\text{BMI (Body Mass Index)} = \frac{\text{body mass } [kg]}{height\ \hat{}2[m\hat{}2]} \quad (1)$$

The body mass index (BMI) is an indicator, with scientific recognition, which aims to reveal a link between the height-weight ratio on the one hand and the level of health on the other. Statistics show that people whose body mass index is in the range of 18.50 - 25 have a better state of health. Exceeding this range, plus or minus, represents a risk for the state of health. Body mass index values above 25 coincide with a proportional increase in health problems - the higher the weight, the greater the risk of health problems.

Pulse and blood pressure were measured once before starting the climb and after each stage of the experiment.

In the first stage pulse and blood pressure were measured (see Table 2), in a normal state (without AW), before climbing stairs (130 stairs). The ascent lasted approx. 90 seconds for each subject (see **Error! Reference source not found.**). The climbing route (see **Error! Reference source not found.**) was the same for both experiments, a location nearby to our department and students' dormitories. This climbing route is usually used at least 2 times a day, for activities in our department and for food supply. This is a usual activity for students and professors, but not only, every day, each human has activities that imply climbing and descending stairs. Also, it should be taken into consideration that, generally, not all climbing routes respect the same model and have different principles of construction leading to different types of locomotion and generating a different influence on the human physiological parameters. This shall be taken into consideration in another study.

Fig. 1. The climbing route, respectively the duration of the climb

The second stage was carried out with AW, i.e. 15 kg (bottled water placed on the back in a backpack-9 kg, and 3 kg in each hand) (see Fig. 2). The climbing route was the same and had to be done in 90 seconds.

Table 2.

Values without AW

No.	Age	Height (cm)	Weight (kg)	BMI (kg/m^2)	Pulse before (BPM)	Pulse after (BPM)	Blood pressure before systolic/diastolic (mmHg)	Blood pressure after systolic/diastolic (mmHg)
1	25	164	67	24.91	57	110	120/78	126/70
2	24	166	57	20.69	61	122	122/78	131/84
3	23	152	50	21.64	60	111	117/80	135/75
4	24	160	52	20.31	77	105	119/78	128/82
5	24	158	55	22.03	80	118	124/84	130/85
Mean/SD							Mean	
	24/0.63	160/4.9	56.2/5.91	21.92/1.62	67/9.52	113.2/6.05	120/80	130/79

Table 3.

Values with AW

No.	Age	Height (cm)	Weight+15 (kg)	BMI (kg/m^2)	Pulse before (BPM)	Pulse after (BPM)	Blood pressure before systolic/diastolic (mmHg)	Blood pressure after systolic/diastolic (mmHg)
1	25	164	82	30.49	57	173	120/78	150/95
2	24	166	72	26.13	61	150	122/78	143/88
3	23	152	65	28.13	60	180	117/80	155/92
4	24	160	67	26.17	77	154	119/78	148/89
5	24	158	70	28.04	80	165	124/84	152/93
Mean/SD							Mean	
	24/0.63	160/4.9	71.2/5.91	27.8/1.6	67/9.52	164.4/11.25	120/80	150/91

Fig. 2. Climbing the stairs with AW.

A considerable change was noted (see table 3). It should be noted that the participating subjects were of the same age, not considering in this study the state of health, physical condition, medical history, and other parameters that can influence the measured values. Observations were made strictly based on changes in values due to physical effort.

3. DISCUSSIONS

Large differences can be observed between the pulse measured before and after the climb, respectively when there was an AW during the climb. These differences are also observed when measuring blood pressure. According to the graphs, it can be seen the influence of climbing without AW (see Fig. 3) and with AW (see Fig. 4). According to the tables (see Table 2 and Table 3), there is an increase in blood pressure before and after in the case without AW and a significant increase in blood pressure before and after in the case with AW.

The highest amplitude (pulse and blood pressure systolic- with AW) was seen in the case of subject 3 followed by subject 1, both with BMI greater than 28.1. Although all the subjects showed increased values for both parameters.

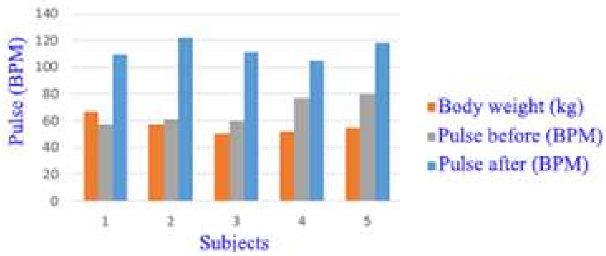

Fig. 3. Pulse variation before and after the climb without AW

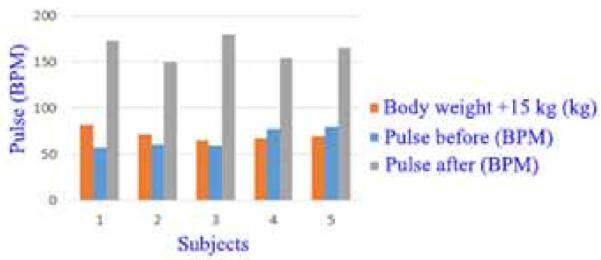

Fig. 4. Pulse variation before and after the climb with AW

The study duration was 10 minutes, very small compared to the duration of actual daily activities which is greater and so it might result in serious heart problems.

4. CONCLUSIONS

In conclusion, the hypothesis based on which this study was carried out is true. Specifically, weight influences vital parameters, such as pulse and blood pressure, depending on the type of exercise.

This hypothesis was supported both by the values obtained and observed during the measurements, as well as by the calculations, respectively by representation using the graphic method.

At the same time, an increase in heart rate and blood pressure was observed in situations such as climbing without weight and climbing with weight.

Thus, it should be taken into consideration what AW is supported by the human body in its daily activities.

Acknowledgments. This study was done with the consistent contribution of students Boglarka Csiki and Leila Joudi.

Conflict of Interest. The authors declare that they have no conflict of interest.

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Influența greutății suplimentare asupra parametrilor fiziologici ai sistemului circulator

Rezumat: Această lucrare are ca scop identificarea influenței greutăților suplimentare (GS), asupra spatelui sau a mâinilor, asupra funcționării sistemului cardiac/circulator. Greutatea, precum și activitățile zilnice (urcarea și coborârea scărilor, alergatul, mersul etc.), au diverse efecte asupra funcției sistemului cardiac, după cum bine știm, senzații precum palpitațiile sau hiperventilația. Având în vedere informațiile de mai sus și folosind un tensiometru și un pulsioximetru s-au studiat influențele activităților cu GS asupra funcționării sistemului circulator. S-a ajuns la concluzia că GS influențează parametrii vitali, precum pulsul și tensiunea arterială, în funcție de tipul de activitate. Influențele apar chiar și în absența greutății.

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