Cardiovascular Load As An Indicator Of Optimal Burdening In Lifting And Carrying Object Of Indonesian People

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ABSTRACT

A research about optimal burdening in lifting and carrying of Indonesian people by considering the cardio-vascular load has been conducted experimentally on 43 normal healthy adults of Indonesian people represented by students of Public Health School. Sample was taken randomly from 64 polpulation of students considering the certain criterias. The result showed that there were significant correlation between optimal burdening in lifting and carrying object (showed by the distance that can be reached safely regarding the CVL) with ages (p=0,00), load (p=0,00), CVL (p=0,049) and resting pulse rate (p=0,095) and with level of significancy of 0,1. Regression model for optimal burdening was :
Distance = 2,414(CVL) – 23,547(Load) – 2,288 (resting pulse rate) + 40,697(ages)
All of the four variables can predict 83,3% of the distance.

***Key words** : Cardio Vascular Load (CVL), optimal burdening, lifting and carrying Object*

INTRODUCTION

Indonesia has no standard for lifting and carrying task yet, while this kind of task is very common in this country especially in manufactur Industries and also in informal sectors. According to some authors in Ergonomists, the burdening of workers in doing a physical tasks can be evaluated by using Cardio Vascular Load as an indicator that the burden is not too excessive and not endanger neither workers' health nor arising fatigue complaints among them (Manuaba,1996; VanWontergghem, 1996 in Tarwaka,2004). %CVL can be measured by using the formula below :

$$\%CVL = \frac{CVL}{OPR - IPR} \times 100\%$$

Whereas :
OPR =Optimal Pulse Rate (Men = 220-ages ; Women=200-ages)
IPR = Initial Pulse Rate (in Resting condition)
CVL= Working Pulse Rate – Initial Pulse Rate

Lifting and carrying object should be done in a certain distance with proper load to prevent musculo-skeletal disorders and arising of fatigue regarding the capacity of cardio-vascular system. This study focus on finding the regression model of factors affecting the optimal burdening.

MATERIAL AND METHODS

This resarch was supported by Indonesian Competitive Grant Project for Univerities in Indonesia (A2-Project). This was a pra-experimental research that was done on 43 normal healthy adults taken randomly from 64 students of Public Health School – Airlangga University Surabaya-Indonesia with certain criterias as follow:

a. Male
b. normal healthy status (confirmed by doctor)
c. in the range of the recent Indonesian Male's Anthropometric standard
d. initial pulse rate 60-90/minutes
e. willing to be subject of this research (proved by informed consent)

The Load

Subjects were asked to do lifting and carrying object (a case) in knuckle height by using different load. First load was 6 kg for each hand (12 kg load). They had to do this job until they felt fatigue and the pulse rate was measured afterward. When they already felt good and recover they can do the second job with 15 kg of loads (7.5 kg for each hand) and so for the third load (20 kg , 10 kg for each hand). Most of them did the next job in the different day.

Instruments

Instruments used in this research were stop watch, Weight and Height Scale Instrument (Health-Smic Model), cases with different load (2 cases for each load) : 6 kg, 7.5 kg and 10 kg with handle (1 cm in width) and hand dynamometer (for measuring the grip strength).

Statistical Analysis

The data than analyzed descriptively and statisticaly by using the linier multiple regression method with level of significancy of 0,1. Dependent variable here was the distance that can be reached without too much load for the cardio-vascular system or without suffering of fatigue (indicated by the CVL). While the independent variables were : the CVL, the load, the resting(initial) pulse rate, ages, grip strength and nutritional status.

RESULTS AND DISCUSSION

Respondents ages were in the range of 19.93-20.22 years old with the averages of 19.93 year and standard of deviation 0.96. Most of the respondents were in a good nutritional status (67.4%) and the rest were under nutrition, overweight and obesity with percentage of 14%, 9.3% and 9.3% respectively. The mean of grip strength was 34.10 kg.

The resting pulse rate of the respondents showed in the below table:

Table 1. The resting pulse rate of the respondents (before doing lifting and carrying jobs), Surabaya November 2009

Load (kg)	Resting Pulse Rate (pulse/minute)		
	Mean	Range	SD
12	79.42	60-90	8.1
15	77.86	58-90	7.85
20	80.42	60-90	8.34

The table above showed that the averages of the resting pulse rate was <90 pulse/minute, so they meet the criteria of this study.

Working pulse rate were measured soon after they did the jobs and showed that the average was <110 pulse/minute. The burden categorized as optimal one when the time needed for recovery was no more than 5 minutes. To know whether the burdening given by the task was optimal or not, see the table below:

Table 2. The working pulse rate with the different load according to optimal or un-optimal Burdening, Surabaya, November 2009

Load (kg)	Workng pulse rate (pulse/minute)			
	Optimal burdening		Un-optimal burdening	
	Mean	SD	Mean	SD
12	90.35	11.82	108.42	12.74
15	95.00	12.61``	111.35	16.35
20	97.25	15.78	109.12	13.46

The table showed that the heavier the load was, the higher the working pulse rate would be. The average of CVL were in the range of 12 – 18 pulse/minute for optimal burdening.

Respondents were instructed to do this lifting and carrying task in a proper way to prevent musculo-skeletal disorders (MSDs). As Halliday said that manual material handling should be done correctly regading ergonomic principle to prevent MSDs (Halliday,J.,1997).

Correlation between variables

According to the analysis using multiple linier regression with distance as the dependent variable, grip strength was the only independent variable that statistically not significantly affected the distance (p>0.1). While the other four variables significantly affected the distance were the load (p=0.00), ages

(p=0.00), initial pulse rate (p=0,095) and CVL (p=0.049) as seen in the Table 3. The Regression Coeficient regression variable table below:

	Regession Coeficient (unstandardized)	Standardized Coefficient	Significance value (p)
CVL	2.414	0.153	0.049
Load (kg)	-23.547	-1.152	0.000
Initial pulse rate	-2.288	-0.546	.0.095
Ages (year)	40.697	2.422	0.000

With distance as dependent variable, the regession model for measuring the optimal distance that can be reached safely (so it was the optimal burdening) was:

Distance =2.414(CVL) - 23.547(Load)-2.288 (initial or resting pulse)+ 40.697(ages).

This research has done in the dry season with rather warm and very humid climate (Relative Humidity > 90%), typically in tropic condition.

DISCUSSION

Chaffin (1979) and Guo et al (1995) in Tarwaka (2004) said that generally muskulo-skeletal complaints begin at 35 years old, while accoording to Betti'e et al (1989) the muscle has it maximal strengath at 20-29 years old. According to those statement, the ages of the respondents were ideal for being the subject of this study (Tarwaka,2004).

Nutritional status is a factor that can affect the physical fitness of human being. It is also affect the physical capability for doing physical demanding work. People with the better nutritional status will have the better endurance in doing physical activities (Borenstein et al, 1995). Most of the subject were in the good nutritional status, so they can did the job (as the subject of this study) with not too much developing fatigue.

Although there is no standard of grip strength to do lifting and carrying tasks, the result showed that respondents with the higher grip-strength values had the tendency to reach the longer distance .

The regression analysis showed that the adjusted R square was 0.833. It mean that the four independent variables (ages, CVL, Load and initial pulse rate) can 83.3% affected the magnitude of the distance. In this research the handle of the load was comfortable one. The result also showed that the most significant variable was ages, followed by the load, CVL and the initial pulse rate respectively.

With the formula produced by this study we can estimate about the distance can be reached in doing lifting and carrying activities using two hand in knucle height without endangering our health. Table below is an example of the implification of the formula. In the below table we can make conclussion that the higher the initial pulse rate, the older we are and the heavier the load, the shorter the distance could be reached safely with the same CVL. This is true theoritically when the ages is no more than 29 year. Theoritically, when the ages is older than 29 year the distance can be reached should be decline, but it need to be proved with the next study.

Table 4. The optimal distance with different initial pulse rate, ages and CVL for 10 kg load

Ages (years)	Initial pulse rate (pulse/minute)	Optimal distance in CVL 0f 16-20 (m)				
		16	17	18	19	20
19	60	439.17	441.531	443.945	446.359	448.773
	70	416.232	418.651	421.065	423.479	425.893
	80	393.357	395.771	398.185	400.599	403.013
	90	370.477	372.891	375.305	377.719	380.133
20	60	479.814	482.228	484.642	487.056	489.47
	70	456.934	459.348	461.762	464.176	466.59
	80	434.054	436.468	438.882	441.296	443.71
	90	411.174	413.588	416.002	418.416	420.83
21	60	520.11	522.925	525.339	527.753	530.167
	70	497.631	500.045	502.459	504.873	507.278
	80	474.751	477.165	479.579	481.993	484.407
	90	451.871	454.285	456.699	459.113	461.527
22	60	561.208	563.622	566.036	568.450	570.864
	70	538.328	540.742	543.156	545.570	547.984
	80	515.448	517.862	520.276	522.690	525.104
	90	492.568	494.982	497.396	499.810	502.224

From the table above, when a normal healthy adult man (22 years old) has an initial pulse rate of 70 pulse/minute, he can reach the safe distance (so it is the optimal burdening) in the range of 538.328 – 547.984 m. While with the same CVL, a 21 years old can only reach 497.631-507.278.

CONCLUSSION

From the result above it can be concluded that the optimal burdening (indicated by the distance can be reached safely) is significantly affected by four dependent variables namely CVL (pulse/minute), the load weight (kg), the resting or initial pulse rate (pulse/minute) and the ages for normal

helthy adults of Indonesian people in the ages' range of 19-22 year.

The four independent variables (ages, CVL, Load and initial pulse rate) can 83.3% affected the magnitude of the distance. The regression models produced by this study is: Distance = 2,414(CVL) – 23,547(Load) – 2,288 (resting pulse rate) + 40,697(ages)

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