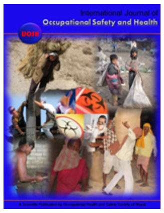


Available Online at http://nepjol.info/index.php/IJOSH

International Network for the Availability of Scientific Publications INASP

International Journal of Occupational Safety and Health, Vol 2. No 2 (2012) 23 - 26

Original Article

Physiological changes in cycle rickshaw pullers after strenuous exercise

Debashis Manna ,Sridhar Thakur, Chandan K Pradhan.

Ergonomics Department, Regional Occupational Health Centre (Eastern),

(Indian Council of Medical Research), Salt Lake, Kolkata, West Bengal

Abstract:

Cycle Rickshaw is a human-powered transportation device. A large number of people remain engaged in the occupation of pulling cycle rickshaw.

The objectives of the study were to assess nutritional status of the cycle rickshaw pullers and their workload by working heart rate and energy expenditure.

Eighteen rickshaw pullers and eleven control subjects were selected after clinical examination. Subjects were asked to pull the rickshaw in two phases - phase 1 (before lunch) and phase 2 (after lunch) each of 3 cycles of 15 min duration each followed by 15 min rest with two passengers. Heart rate was recorded continuously using a heart rate monitor. Average working heart rate (AWHR), peak working heart rate (PWHR) and energy expenditure (EE) were calculated. Maximal heart rate (HRmax) was also recorded in the laboratory. The control subjects were allowed to work in a cycle ergometer in the laboratory.

There was no significant difference between the mean values of rickshaw pullers and those of control subjects in relation to age, BMI, fat% and HRmax (beats/min). The AWHR, PWHR and EE values of rickshaw pullers showed the workload as 'heavy' to 'very heavy' category.

The result of the study will be beneficial for cycle rickshaw pullers, health administrators and manufacturers of cycle rickshaw.

Key Words: Cycle rickshaw puller, Maximal heart rate, Average working heart rate, peak working heart rate, energy expenditure.

Introduction

Cycle Rickshaw is a very popular human-powered transportation device used extensively in India as well as in many other South-East Asian countries. It is used to carry passengers along with their luggage and merchandise. The people of poor and low socio-economic class remain engaged in the occupation of pulling cycle rickshaw. According to Vijayanunni [1], in West Bengal, 0.26 million people are engaged in this occupation which is 30% of total cycle rickshaw pullers (0.86 million) of India. Rickshaw pullers (RP) have to do strenuous exercise during work for long hours; there is no fixed time for their work. They are exposed to extremes of the weather conditions in different seasons along with other hazardous substances from automobile exhaust. A study from ROHC [2] reported various health problems of the cycle rickshaw pullers. Numerous studies on energy intake and expenditure were carried out in India in people with different occupations [3]. But there is scanty data available on the cycle rickshaw pullers [4] (Pradhan et al 2008). Assessment of physiological responses will be helpful to determine the workload imposed on the cycle rickshaw pullers.

Corresponding Author: Dr. Chandan K. Pradhan.

Email: pradhanck@gmail.com

The study was conducted with the following objectives:

- assessment of nutritional status of the cycle rickshaw pullers
- assessment of their working heart rate and energy expenditure

Methods

Ethical committee clearance was obtained from Regional Occupational Health Centre (E) for the study. A list of rickshaw pullers in the age group of 30-49 years was prepared from different rickshaw stands. A list of control subjects nearly matching with age and socio-economic status was prepared from different localities. Eighteen rickshaw pullers and 11 controls subjects were selected for experiment after clinical examination in order to exclude subjects who were suffering from any kind of disease. Written consent was obtained from each of the participants after informing the purpose, nature and procedure of the study.

Body weight and height of the subjects were recorded. Skinfold thickness at biceps, triceps, subscapula and suprailiac were measured using a Skinfold caliper (Holtain, UK). Body mass index (BMI) of the subjects was derived from weight and height. In order to assess their nutritional status, they were classified according to their BMI [5, 6]. Body composition of the subjects in terms of body fat percentage and lean body mass were assessed [7, 8].

Rickshaw pullers were asked to pull rickshaw in two phases (pre and post lunch). Each phase consisted of 3 cycles each of 15 min work followed by 15 min rest. Heart rate was recorded every minute using a heart rate monitor (Polar Accurex Plus, Finland).

Maximal heart rate (HRmax) of the RP and that of control subjects was evaluated in the laboratory by exercise using a cycle ergometer (Lower Body Cycle; BIODEX, USA). Control subjects were asked to pedal a cycle ergometer (similar to RP in terms of muscle groups involved) in six cycles of 15 min work and 15 min rest. The load was adjusted to produce heart rate in the range of 70-80% of their HRmax. Average working heart rate (AWHR), peak working heart rate (PWHR) and percentage of recovery (PREC) of the RP and control subjects in different phases of work were determined.

Cardiac strain [9] of the task was derived from net cardiac cost (NCC) and relative cardiac cost (RCC). PREC was calculated from the equation of Pradhan et al [10], which expresses the quantum of fall during recovery period as a percentage of the increment of working heart rate over resting heart rate. The energy expenditure (EE) of pulling rickshaw was determined from the recorded heart rate [11] and average energy cost was calculated considering all the six cycles.

All the experiments started in the morning at around 10:00 hours. During the experiments, dry bulb temperature was 21 - 32℃, wet bulb temperature was 14 - 28℃, globe temperature was 22 – 35.5℃ and wet bulb globe temperature index value was 16.8 – 30.3℃.

Results

Physical characteristics of the rickshaw pullers and control subjects have been presented in Table 1. The age of the rickshaw puller varied from 30 to 47 yrs and that of control were 30 to 45 yrs. Results showed that there was no significant difference between the mean values of rickshaw puller and control subjects in relation to age, BMI and fat%. There was no significant difference between observed HRmax (beats/min) values of RP (180 ±4.3) and that of control subjects (181 ± 3.1).

Table I Vibration magnitude (A_{eq}) and health risk assessment .

Parameters	Rickshaw Pullers (n=18)	Control (n=11)
Age (yrs)	37.2± 6.0	35.6± 4.4
Height (cms)	159.7 ± 5.8	166.7 ± 4.4
Weight (kg)	50.4 ± 5.7	59.4 ± 9.1
BMI (kg/m^2)	19.8 ± 2.2	21.3 ± 2.9
HR_{max} (beats/min)	180 ± 4.3	181 ± 3.1
Fat%	14.7 ± 4.7	15.9 ± 7.6
Fat (kg)	7.8 ± 2.7	9.8 ± 5.6
Lean body mass (kg)	45.0 ± 3.4	49.5 ± 5.8

Heart rate patterns of the rickshaw puller and control subjects in different phases of work are shown in Fig 1. It was observed that values of all the cycles of Phase 2 were less than those of Phase 1 in both the groups. The difference in heart rate values between the rickshaw pullers and control subjects during work were more in Phase 1 compared to Phase 2. During recovery in all cycles of both phases, the pattern of heart rate values were almost same in both the groups.

The values of average working heart rate (AWHR), peak working heart rate (PWHR), energy expenditure (EE), net cardiac cost (NCC), relative cardiac cost (RCC), percentage of recovery (PREC) of the rickshaw pullers and control subjects in all six cycles of different phases of work have been presented in Table 2. The AWHR of 15 minutes work of all the cycles was computed from minute-by-minute data of all rickshaw puller and was worked out to be 129.1 ± 14.6 to 136.3 ± 12.9 beats/min case of Phase 1 and 129.3 ± 11.4 to 131.5 ± 12.4 in case of Phase 2 of pulling rickshaw. In case of control subjects, the AWHR values of all the cycles of both phases ranged from 118.4 ± 9.1 to 125.7 ± 5.5 beats/min.

RP and control subjects in both the Phases. It ranged from 61 to 64% (RP) and 63 to 67% (Control).

Discussion

Body mass index values indicated that both Rickshaw pullers and Control groups were within 'normal' category [12, 5]. Lean body mass of the present rickshaw pullers were similar with those reported earlier involving 33 cycle rickshaw pullers of Kolkata [2].

Table II Physiological responses of rickshaw pullers and control subjects during different cycles of work.

Parameters	Phase 1						Phase 2					
	Cycle I		Cycle II		Cycle III		Cycle I		Cycle II		Cycle III	
	RP	Control	RP	Control	RP	Control	RP	Control	RP	Control	RP	Control
AWHR (beats/min)	129.0 ±14.5	118.7 ±11.2	136.3 ±12.9	124.1 ±8.9	135.6 ±13.2	125.5 ±9.9	129.3 ±11.4	118.4 ±9.1	131.5 ±12.4	122.2 ±8.4	129.8 ±14.2	125.7 ±5.5
PWHR (beats/min)	144.9 ±15.3	141.4 ±12.7	147.3 ±14.2	143.3 ±8.2	150.8 ±15.8	144.3 ±9.5	142.4 ±12.9	136.36 ±7.7	141.3 ±11.8	135.2 ±7.9	141.7 ±15.8	140.2 ± 7.3
EE (k cal/min)	5.10 ±0.69	4.94 ±0.57	5.21 ±0.64	5.03 ±0.37	5.37 ±0.71	5.07 ±0.43	4.99 ±0.58	4.72 ±0.35	4.94 ±0.53	4.66 ±0.35	4.96 ±0.71	4.89 ±0.33
NCC (beats)	966 ±239.2	748 ±152.5	1032 ±226.2	799 ±117.8	1056 ±274.8	821 ±117.9	964 ±222.5	740 ±111.9	960 ±221.2	771 ±92.9	934 ±243.0	823 ±127.3
RCC (%)	57.3 ±12.7	45.4 ±9.1	61.2 ±10.9	48.0 ±6.0	62.4 ±13.2	50.0 ± 7	57.0 ±10.2	44.9 ±6.5	56.8 ±10.7	46.8 ±4.9	55.3 ±12.4	49.7 ±5.1
% recovery	64.3 ±16.7	66.0 ±8.0	61.1 ±16.2	66.0 ± 7.0	64.4 ±15.1	64.0 ±9.0	63.2 ±14.2	64.2 ±11.2	60.9 ±14.7	63.4 ±13.6	61.3 ±19.9	66.4 ±7.8

The mean value of PWHR (beats/min) of all the rickshaw puller ranged from 144.9 ± 15.3 to 150.8 ± 15.8 and 141.3 ± 11.8 to 142.4 ± 12.9 beats/min while in case of control subjects it was 141.4 ± 12.7 to 144.3 ± 9.5 and 135.2 ± 7.9 to 140.2 ± 7.3 beats/min in Phase 1 and 2 respectively.

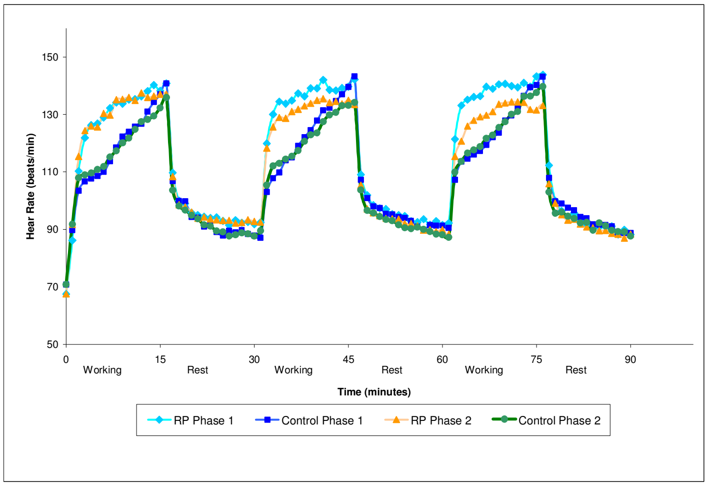
The mean values of EE (kcal/min) of pulling a cycle rickshaw during Phase 1 and Phase 2 varied from 5.10 ±0.69 to 5.37 ± 0.71 and 4.94 ±0.53 to 4.99 ±0.58 respectively. There was no significant difference in EE between rickshaw pullers and control subjects in all cycles of Phases 1 and 2.

Table 2 also shows NCC and RCC of cycle rickshaw pullers and control subjects at different cycles. In respect of NCC, significant difference ($p<0.01$) was observed between the cycles of Phase 1 and Phase 2, except cycle III of Phase 2. The mean values of recovery percentage revealed no significant difference between

The pattern of working and recovery heart rates observed in two phases of the present study was almost same in rickshaw puller as well as control subjects (Figure 1). It was observed that the heart rate did not reach the resting level in any of the cycle rickshaw pullers even after 15 minutes of recovery period. Percentage recovery of the rickshaw pullers in the present study was similar with those of Chinsurah (67.7%) and Patna (68.5%) as reported by Pradhan et al [4]. The rickshaw pullers often have to start a fresh work cycle even before a rest pause of 15 min. Thus a fresh work cycle often starts before complete recovery from the previous spell of work, leading to accumulation of fatigue.

The AWHR and PWHR of all the rickshaw pullers showed the workload as 'heavy' and 'very heavy' category [13, 14] in all the phases. In case of control subjects, these values indicated the

Figure 1. Comparison of working and recovery heart rate (mean) of the RP and control subjects.



workload as 'heavy' category. The values of EE showed the job of rickshaw pulling can be categorized as 'heavy'. This observation is supported by earlier findings [10, 4]. In respect of EE, the job of control subjects was also 'heavy'.

Conclusion

The result of the study will make the cycle rickshaw pullers aware of the hazards of their occupation. They could be guided for taking care of their health by improvising their living style and work practice. These will also help the health administrators to take policy decision for administering better health care for the rickshaw pullers. The manufacturers of cycle rickshaw would be able to use the data for fabricating newer model of cycle rickshaw which would require less energy to drive. Thus the rickshaw pullers would be benefited.

References

1. Vijayanunni M. Census of India, Series 1 – India, Part III B – B Series, Economic Tables, Volume – 8 (Part – 1, Part – 2 & Part – 3), Table B – 19 (F), India, States & Union Territories, Govt. of India, 1991.
2. ROHC. Evaluation of Occupational Health Problems of Cycle Rickshaw pullers and Re-design of Cycle Rickshaw on Ergonomic Principles. Kolkata: Regional Occupational Health Centre, 2009.
3. Rajalakshmi R. Perspectives in Nutrition. Baroda: .M S University of Baroda, 1972.
4. Pradhan, CK, Thakur, S, Mukherjee, A, and Roychowdhury A. Energy expenditure of cycle rickshaw pullers in different places in India. Ergonomics 2008, 51: 1407-1417.
5. WHO. Physical Status: The Use and Interpretation of Anthropometry. World Health Organisation. Technical Report Series No. 854, Geneva: WHO, 1995.
6. Weisell RC. Body mass index as an indicator of obesity. Asia Pacific J Clin Nutr, 2002, 11(Suppl): S681 - S684.
7. Siri WE (1956). The gross composition of the body. In: Advances in Biological and Medical Physics, (Eds) Lawrence JH and Tobias CA, New York: Academic Press,. 1956.
8. Durnin JVGA and Rahaman MM. The assessment of the amount of fat in the human body from measurements of skinfold thickness. Br J Nutr. 1967, 21: 681-689.
9. Costa G., Berti F and Betta A. Physiological cost of apple firming activities. Ergonomics 1989, 20: 281-286.
10. Pradhan CK, Thakur S, Mukherjee AK and Roy Chowdhury A. Physiological assessment of cycle rickshaw pullers. Ind J Physiol & Allied Sci, 2004, 58:113-118.
11. Datta SR and Ramanathan NL. Energy expenditure in work predicted from heart rate and pulmonary ventilation. J Appl Physiol, 1969, 25: 297–302.
12. WHO expert consultation. Appropriate body-mass index for Asian populations and its implications for policy and intervention strategies. The Lancet 2004, 363 : 157 – 163.
13. Astrand PO and Rodahl K. Textbook of Work Physiology (3rd ed) , New Delhi: Mc-Graw Hill Book Company, 1986
14. Sen RN and Nag PK. Work organization of heavy load handling in India. J Human Ergology 1975, 4: 103-113.

Acknowledgement

The authors are thankful to Department of Science & Technology, Govt of India, for financial support. They sincerely acknowledge the Director, National Institute of Occupational Health, Ahmedabad, for his kind permission to undertake the study. They also thank the cycle rickshaw pullers for their participation in the study.