

Effect of Carrying 20% of Body Weight in Backpack on Physiological Responses & Energy Expenditure in School Children

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Abstract

Objective: The purpose of this study was to determine the changes in heart rate, respiratory rate, blood pressure and energy expenditure while walking without and with backpack in school going children. **Method:** Forty six subjects, (24 boys and 22 girls) were taken in the study. Their resting parameters ie H.R, R.R and B.P were recorded. Then subjects were asked to walk for 6 minutes on the level ground and their parameters were recorded immediately, after 3 minutes and 5 minutes and their physiological cost index was calculated. Resting time was given to the subjects to bring their parameters to baseline and then subjects were asked to walk again for 6 minutes with 20% of their body weight in backpack and the same procedure was repeated. **Result:** There was a significant difference in H.R, R.R and P.C.I in walking without and with backpack ($p < 0.01$). However there was no significant difference in B.P. in without backpack walk and with backpack walk.

Keywords: Heart Rate (H.R.); Respiratory Rate (R.R.); Physiological Cost Index (P.C.I.); Systolic Blood Pressure (S.B.P) and Diastolic Blood Pressure (D.B.P).

Introduction

Backpack use among school children is the most popular means of transporting belongings to and from school. The backpack is an appropriate way to load the spine closely and symmetrically, while maintaining stability.

Overloaded children backpacks may lead to the development of back pain, musculoskeletal injuries, alteration in posture to accommodate backpack and maintain upright equilibrium [1]. The relative load carried by school children (expressed as percentage of Body Weight) has been considered as one of the contributory factors for developing musculoskeletal problems among the children.

Authors have discussed association between backpack load and physiological responses which

includes cardiovascular, pulmonary and metabolic changes. Cardiovascular changes due to backpack use include responses in heart rate, blood pressure, and metabolic rate, as well as brachial artery flow. Heart rate and oxygen uptake are both influenced by the backpack weight while walking. Heart rate also increases while standing with a backpack, regardless of weight or support [2].

Even studies have reported significant decrease in brachial artery blood flow in school age children carrying a backpack of 20% bodyweight which further decreases when the backpack load is worn high on the back as compared to lower on the back [3].

Lung function is also compromised in children by carrying 10, 20, & 30% of body weight in backpack compared standing with or without backpack, or with a kyphotic posture [4]. With increased backpack loads, thoracic volume (activation of thoracic respiratory muscles) also increases [5]. There is a linear relationship between the energy expenditure while walking with a backpack load [6].

The load carried in a double strap backpack requires less oxygen consumption in children as compared to a load carried on one shoulder (which required 37% more energy than the backpack) or a load carried in one hand (which required 82% more energy than the backpack [7]. Mean work intensity

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measurements of oxygen consumption and energy expenditure in children increases as the weight in backpack increases.

Need of the Study

The previous studies deals with parameters like musculoskeletal pain, biomechanical changes in gait, posture, cardio respiratory adjustments, energy expenditure and fatigue. However, there is a less literature available which has studied influence of load carriage in backpack on physiological system in normal school going children.

Operational Definition

- *Arterial Blood Pressure:* It is the lateral pressure on the walls of the arteries due to flowing column of the blood.
- *Heart Rate:* The number of heartbeats per unit time, usually per minute.
- *Physiological Cost Index:* It is an energy index based on heart rate. It determines the relative cost of walking per unit distance walked.
- *Respiratory Rate:* The number of breaths per minute.
- *Borg Scale:* It is a simple method of rating perceived exertion. RPE scale runs from 0 to 10. The numbers use to rate how easy or difficult one finds an activity.
- *Sedentary Lifestyle:* It is a type of lifestyle with no or irregular physical activity.

Materials and Methodology

Methodology

The methodology adopted for this study is described below.

Study Design

Pre-post study design

Study Duration

Six months

Sampling Method

Purposive sampling

Place of Study

Different schools of Meerut

Inclusion Criteria

- School going children aged 8 to 10 years

Exclusion Criteria

- Any congenital and structural abnormalities.
- Presence of musculoskeletal problems.
- History of any neurological problems.
- History of cardio respiratory problems.
- Acute illness (e.g.; fever, cough etc)

Outcome Measures – BP, HR, RR, P.C.I

Materials Required

- Stop watch
- digital blood pressure apparatus
- weighing machine
- Measuring tape

Procedure

Ethical approval was obtain from the board of studies department of physiotherapy, Swami Vivekanand Subharti University.

Forty six subjects, 8 to 10 years old school children were taken in the study. Voluntary participation for the study was considered. An informed consent was taken from the principal of the school. For each participant backpack questionnaire was filled by interview method.

Subjects were fully explained about the procedure and then their resting parameters i.e heart rate, blood pressure and respiratory rate were recorded.

After that subjects were asked to walk for 6 minutes on the level ground and after 6 minutes walk their BP, HR, RR were recorded immediately, 3 minutes and 5 minutes and their physiological cost index was calculated.

Resting time of 10 minutes was given to subjects to bring their parameters to baseline. Then again they were asked to walk for 6 minutes with backpack which contain 20% of their body weight and after that their BP, HR, RR were recorded immediately, 3 minutes, 5 minutes and again their physiological cost index was calculated. Rating of perceived exertion was asked after the child had walked without and with backpack.

Data Analysis

- All analysis was done by using the SPSS version

20.0 (for window 7)

- Demographic data of subjects were summarised.
- To analyze the difference between the two groups, paired t-test was used. A level of 0.01 was used to determine the statistical significance.

Results

TOTAL NO OF CHILDREN – 46

NO OF BOYS- 24

NO OF GIRLS – 22

NO OF 7 TO 8 YEARS STUDENTS – 10

NO OF 9 TO 10 YEARS STUDENTS – 36

For H.R., R.R., B.P. & P.C.I. in All Children

Table 1 shows the comparison between the

different positions of H.R, R.R, P.C.I. and B.P. (by paired ‘t’ test) in children.. It shows a significant difference for each pair of position of H.R, R.R. and P.C.I. at 0.01 level of significance. i.e. (p<0.01). It also shows significant difference for S.B.P and D.B.P between at resting and without backpack walk, resting and with backpack walk, and no significant difference at without backpack walk & with backpack walk at 0.01 level of significance (p<.01).

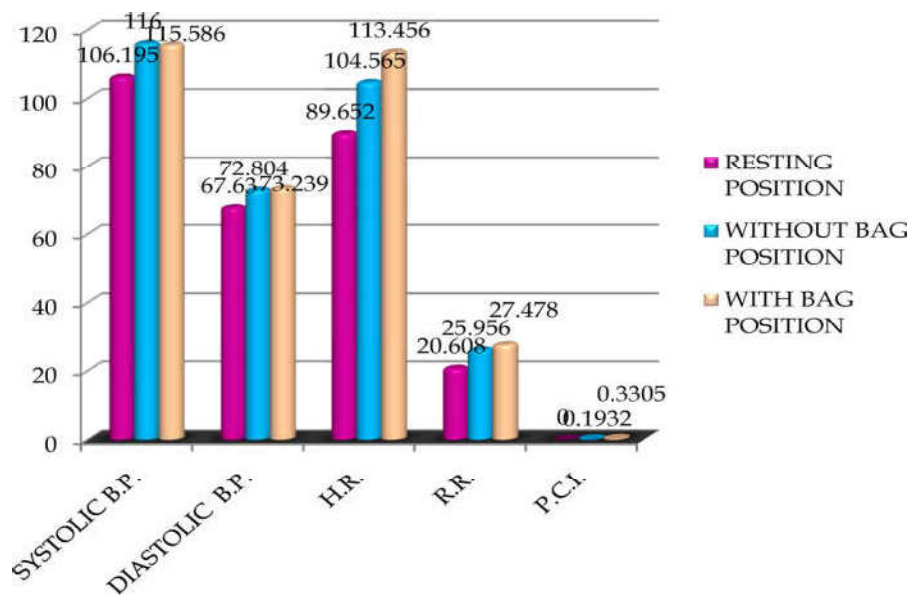
Table 2 shows a significant difference for each pair of position of H.R.,R.R., and P.C.I. at 0.01 level of significance. i.e. (p<.01).It also shows significant difference for S.B.P and D.B.P between resting & without backpack walk and resting & with backpack walk and no significant difference between without backpack walk & with backpack walk(p<.01).

Table 1: Comparison between different positions (in pairs)

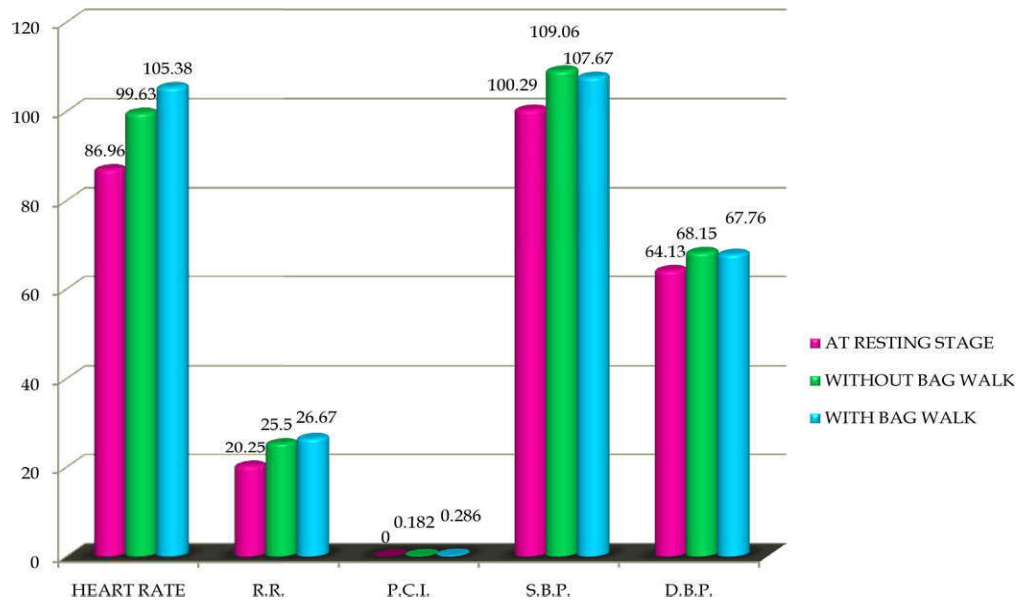
S. No.	Comparison between the positions	Probability of paired “t” TEST FOR				
		H.R.	R.R.	P.C.I.	S.B.P.	D.B.P.
1	Resting & Without Backpack Walk	.0000*	.0000*	----	.0000*	.0000*
2	Resting & With Backpack Walk	.0000*	.0000*	----	.0000*	.0000*
3	Without Backpack Walk & With Backpack Walk	.0000*	.0000*	.0000*	.0906	.4280

Table 2: Comparison between different positions (in pairs) for H.R., R.R., B.P & P.C.I. in male children

S. No.	Comparison between the positions in male children	Probability of paired “t” Test For				
		H.R.	R.R.	P.C.I.	S.B.P.	D.B.P.
1	Resting & Without Backpack Walk	.0000	.0000	----	.0000*	.0063*
2	Resting & With Backpack Walk	.0002	.0000	----	.0000*	.0081*
3	Without Backpack Walk & With Backpack Walk	.0001	.0000	.0013	.0977	.7155



Graph 1: The bar diagram of average scores of s.b.p., d.b.p., h.r., r.r. and p.c.i. for all children at resting, with backpack walk & with out backpack walk positions



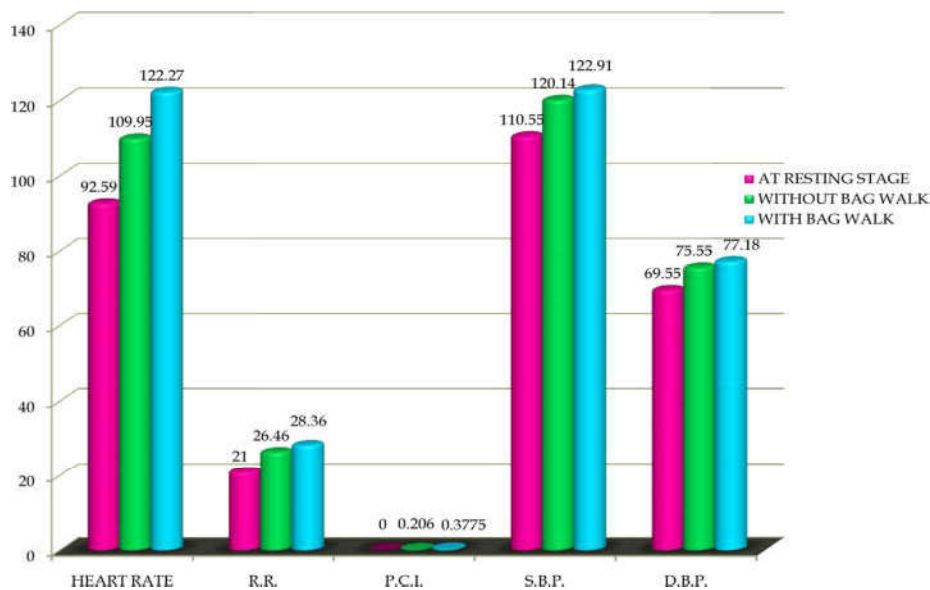
Graph 2: The bar diagram of average scores of h.r., r.r.,p.c.i., s.b.p. & d.b.p. at resting position, without backpack walk position & with backpack walk position in the male children

Table 3: Comparison between different positions (in pairs) for H.R., R.R., B.P & P.C.I. in female children

S. No.	Comparison between the Positions	PROBABILITY OF PAIRED "t" TEST FOR				
		H.R.	R.R.	P.C.I.	S.B.P.	D.B.P.
1	Resting & Without Backpack Walk	.0000	.0000	----	.0000*	.0027*
2	Resting & With Backpack Walk	.0000	.0000	----	.0000*	.0023*
3	Without Backpack Walk & With Backpack Walk	.0000	.0014	.0000	.1274	.2921

Table 3 shows the comparison between the different positions of H.R, R.R, P.C.I, S.B.P & D.B.P. (by paired 't' test) in female children. It shows that a significant difference was present for each pair of position of H.R, R.R & P.C.I at 0.01 level of significance.

i.e. ($p < .01$). It also shows significant difference for S.B.P and D.B.P between resting & without backpack walk and between resting & with backpack walk and no significant difference between without backpack walk & with backpack walk ($p < .01$).



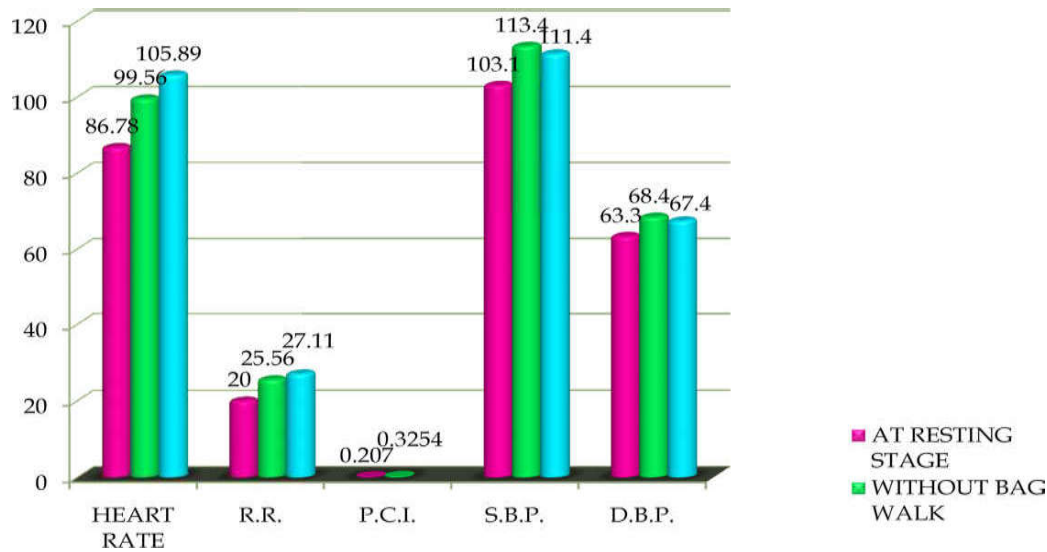
Graph 3: The bar diagram of average scores of H.R., R.R., P.C.I., S.B.P & D.B.P at resting position, without backpack walk position & with backpack walk position in the female children

Table 4 shows a significant difference was present for each pair of position of H.R, R.R, P.C.I. at 0.01 level of significance. i.e. ($p < .01$). It also shows that a significant difference was present for S.B.P between resting & without bag walk at 0.01 level of significance ($p < .01$). No significant difference was

present in S.B.P & D.B.P between resting & with backpack walk and between without backpack walk & with backpack walk. However significant difference in S.B.P was present in resting & without backpack walk.

Table 4: Comparison between different positions (in pairs) for H.R., R.R., B.P. & P.C.I. IN 7-8 years children

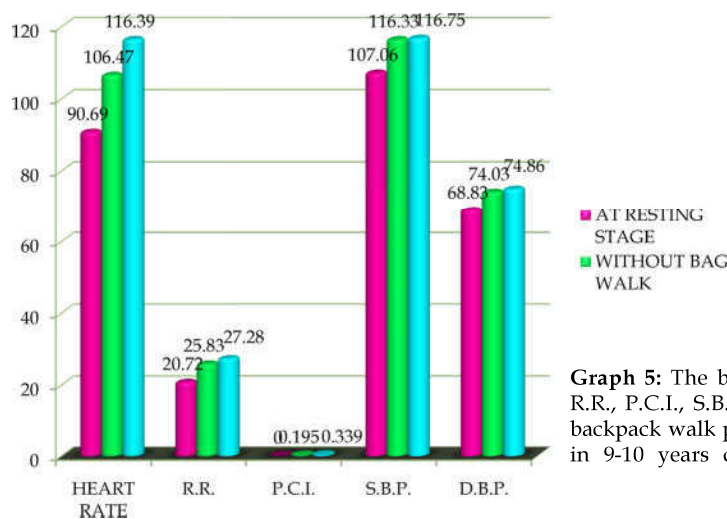
S. No.	Comparison between the positions Test in 7-8 years children	Probability of paired "t" Test For				
		H.R.	R.R.	P.C.I.	S.B.P.	D.B.P.
1	Resting & without backpack walk	.0002*	.0002*	----	.0002*	.0233
2	Resting & with backpack walk	.0000*	.0002*	----	.0229	.1984
3	Without backpack walk & with backpack walk	.0111*	.0081*	.0050*	.3136	.7759



Graph 4: The bar diagram of average scores of H.R., R.R., P.C.I., S.B.P & D.B.P at resting position, without backpack walk position & with backpack walk position in 7-8 years children

Table 5: Comparison between different positions (in pairs) for H.R., R.R., B.P. & P.C.I. by paired "t" in 9-10 years children

Comparison between the positions Test in 9-10 years children	Probability of paired "t" test for				
	H.R.	R.R.	P.C.I.	S.B.P.	D.B.P.
Resting & without backpack walk	.0000*	.0000*	----	.0000*	.0000*
Resting & with backpack walk	.0000*	.0000*	----	.0000*	.0001*
Without backpack walk & with backpack walk	.0000*	.0006*	.0000*	.7815	.4960



Graph 5: The bar diagram of average scores of H.R., R.R., P.C.I., S.B.P & D.B.P at resting position, without backpack walk position & with backpack walk position in 9-10 years children

Table 5 shows a significant difference was present for each pair of position of H.R., R.R. and P.C.I at 0.01 level of significance. i.e. ($p < .01$). It also shows significant difference for S.B.P and D.B.P between resting & without backpack walk and between resting & with backpack walk at 0.01 level of significance and no significant difference between without backpack walk & with backpack walk ($p < .01$).

Discussion

The purpose of this study was to determine the effect of 20% body weight in backpack on physiological responses (H.R., R.R., B.P.) and energy expenditure. In this study alternate hypothesis was accepted i.e., there are significant physiological changes while walking with the backpack. Our result shows that there was increase in energy expenditure while walking with the backpack as compared to walking without backpack. There was also increase in H.R. and R.R. in without backpack walk and with backpack walk as compared to baseline. Difference in blood pressure was also noted in without backpack walk and with backpack walk as compared to baseline. However, there was no significant difference in blood pressure as compared to without backpack and with backpack walk.

Overall, we found increase in H.R. and R.R. in without backpack walk and with backpack walk as compared to baseline. Our result is in accordance with Hong et al who examined heart rate, blood pressure and energy expenditure in children carrying backpacks weighing 10, 15, and 20% BW compared to not wearing a backpack, and found increased heart rates across all loads, which returned to normal after a brief recovery period [8]. This is also supported by the study done by Li JX, Hong Y Robinson PD (2003) that breathing frequency increases with the load carriage [9]. Like the results of You Lian Hong and Bruggeman GP decrease in walking speed with backpack was also observed [10].

Measurements of blood pressure immediately after walking without backpack and with backpack for 6 minutes show significant difference as compared to baseline. We also found increase in S.B.P while walking. However, there was no difference in blood pressure in walking without backpack and with backpack, this could be due to decrease in walking speed with 20% load carriage. Also, adaptive responses that occur during without backpack walking could be a contributing factor for not increasing B.P. after 20% load carriage walk.

Therefore, the changes of blood pressure in this study indicate that the load of 20% of body weight produced a greater stress on the cardiovascular system in terms of H.R and R.R.

We found increase in energy expenditure while walking with backpack as compared to walking without backpack. This was also seen in the study done by Veisteinas, Merati & Negrin who found increase in H.R and net energy cost of locomotion while walking with the backpack. We also noticed higher Rating of perceived exertion while walking with backpack [11]. This is in accordance with study done by Quesada PM et al who also reported higher energy cost and RPE with increased backpack [6].

We also studied effect of gender on physiological parameters and energy expenditure with load carriage. We found no statistically significant differences on H.R., R.R. and B.P. on the basis of gender. This could be attributed as all children included in our study were in prepubescent phase. Before puberty physiological responses are same in male and females [12].

We also noticed that children with the sedentary lifestyle required more time for H.R, R.R. and B.P recovery. However, statistical test couldn't be done because of less sample size in sedentary children group.

Clinical Implication

- Sedentary lifestyle children were encouraged to exercise regularly and indulge in outdoor games (Cycling, running, skipping etc) and the teachers were asked to add regular games period in the school timetable.
- Teachers \ Guardians were educated about the harmful effects of heavy backpack and they were asked to reduce the weight of backpack.
- Teachers \ Guardians were also educated about the type of backpack to be used by children. (Backpack with double strap, chest and waist band requires less energy as compared to other types of backpack).

Future Scope of the Study

- Study can be done comparing energy expenditure between ground walking and staircase climbing or ramp walking.
- Study can be done on the children with special needs
- Effect of BMI on physiological parameters with load carriage can be studied.

Conclusion

Data analysis of this study concluded the following :-

- There was increase in H.R. and R.R. while walking without backpack and walking with backpack as compared to baseline.
- There was also increase in energy expenditure and perceived exertion while walking with backpack as compared to walking without backpack.
- There was no effect of gender on physiological parameters and energy expenditure with 20% load carriage.

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