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# Load carrying behavior: passengers and other people

## Abstract

Carrying loads is an everyday behavior. This includes travel. Passengers use different containers to carry loads. These containers are held at hands in front of the body, put on shoulders or on head, keep at the side of the body, held on straps of a bag or backpack. Several people lift a luggage in a wrong manner. They lean their body over a load while having straightened lower extremities. From the biomechanical point of view holding a load on the head gives proper impact on the whole body. Laying down a load on a shoulder is better than holding a load in front of the trunk or holding in hand at the side of the trunk. The latter gives the highest amount of the gravitational moment of force which should be equalized by muscles activity. Using a backpack is the best idea of transporting a load. People should be taught at schools, during studies how to handle a load.

**Keywords:** load, human body, biomechanics, passengers

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## Introduction

For many years people needed to carry loads. This was done for everyday living, for hunting, building, fighting with enemies and other purposes. Also one of the important aims of carrying loads is travels. Passengers use to hold different luggage which contains their belongings.

Passengers use different containers to carry the load. These are: textile, leather, or plastic bags, sacks, baskets, suitcases, backpacks, cardboard or wooden boxes. These containers are: held at hand, put on shoulder or on head, keep at the side of the body, held on straps of a bag or backpack.

As Fumery et al. mentioned,[1] there are several studies on load carriage including porters,[2] ergonomic assessment of activities,[3] military personnel,[4] sports athletes.[5] The author did not find articles on load carrying behavior of passengers. The aim of this study is to present problems of passengers carrying different loads.

## Lifting and holding a load

### Lifting a load

Several people lift a heavy load in a wrong manner. They lean their trunk over a load while having lower extremities straighten. They are not taught how to manage lifting a load. Even some signs spotted at the street do not help – Figure 1a.

Few years ago students of the physiotherapy major (field of study) were asked to show how to manage lifting a load. In their future work lifting a patient will be an often activity. Some of students (males and females) presented very wrong approach to this activity. They had:

a. Almost straighten lower extremities;

b. Horizontal position of the trunk and head;

c. Arched vertebral column;

d. Some distance between toes and a load (Figure 1b).

Such approach to the lifting of a load as shown in Figures 1a and 1b are a reason why so many people suffer from the low back pain. Figure 1c shows correct approach to the lifting a load shown by biomechanist. He has:

a) flexed lower extremities at knee joints up to around 90 degrees;

b) position of a trunk at around 45 degrees;

c) straighten vertebral column;

d) feet positioned at the side of a load, so the vertical line of gravity force of a load is close to the centre of mass of the human body (Figure 1c).[6]

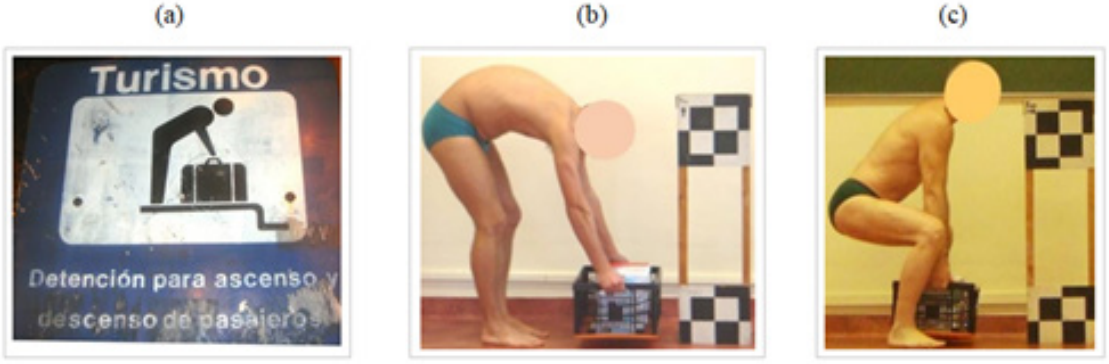


**Figure 1** Lifting a load:

a) wrong technique of lifting a load on a street sign in Buenos Aires; b) wrong technique of a student while lifting a load; c) correct technique of biomechanist.

## Holding a load

The author made photographs of passengers carrying loads heading to the Cairo (Egypt) railway station.

They presented different activities while carrying luggage. Taking into account examples of Figure 2a–c hands, one or both, shoulder, hip, head are involved in carrying a load, while examples presented in Figure 2d show situation where passengers use a bag and a backpack and two upper extremities are free for different purposes, including amortization when somebody stumbles and falls. Passengers shown in Figures 2a–c represent Egyptians, while those in Figure 2d represent tourists from the European Union.


**Figure 2** Carrying of a load using different parts of the body:

a) Hand and shoulder; b) hip; c) head; d) combined – shoulders, back, hip.

## Biomechanical analysis

From the biomechanical point of view, a load closer to the axis of vertebral column the better. This fulfills holding a load on the head.[7] Unfortunately, such loads cannot be too heavy since the head is vulnerable and neck joints are not prepared to deal with a high load.

Loads carried at the front of the body are far away from the vertebral column. This is why they are positioned partly on the abdomen. Nevertheless the length of force arm "r", i.e. a distance between lumbar joints and vertical line of the gravity force "R" is large. In this case a moment of force, i.e. $M.R = R \times r$, is also large (Figure 3a). For example, taking R as 150 N and r as 0.4 m, moment of force yields 60 N × m. For a short time this is not a large value, but a person carries such a load for a long time and this is a source of exhaustion.

Loads situated on the shoulder (Figure 3b) are closer to the vertebral column comparing to holding load at the hand (Figure 3c). It means that the moment of force in the case of holding a load in the hand is larger around twice as much. This is why an upper part of the vertebral column of a person shown in the Figure 3c was shifted outward of the load. Specific situation is presented in Figure 3d. A boy holds a bag by one handle only and having upper extremity flexed at the elbow joint. In this case a moment of force is even larger comparing to the situation shown in the Figure 3c. His vertebral column is straight because he has another bag at the opposite side (Figure 3).

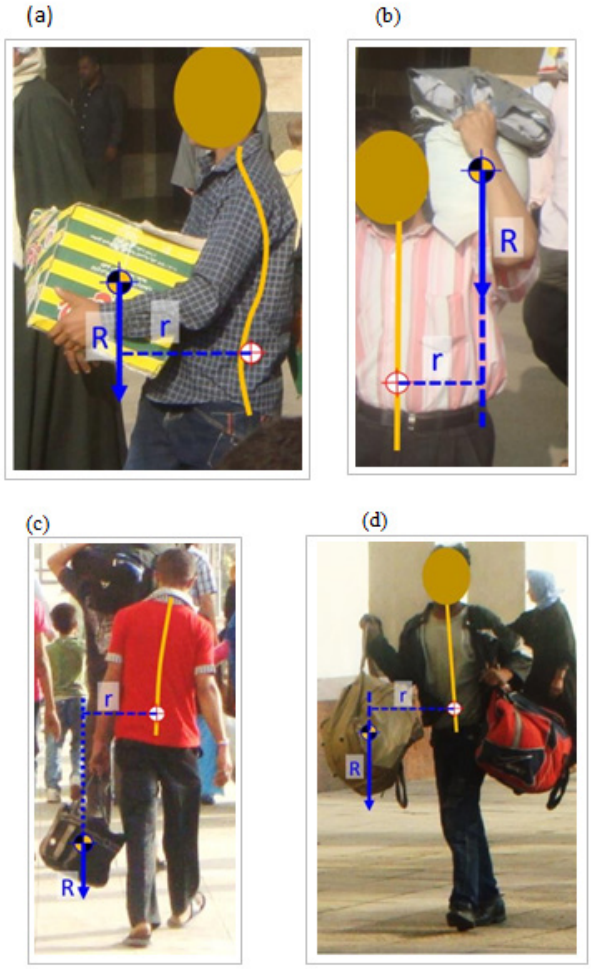


**Figure 3** Resistance forces "R" and arms of forces "r" during holding a load:

a) At the front of the body;

b) On a shoulder;

c) In a hand;

d) In a hand with flexed elbow joint.

## Discussion

From the biomechanical point of view loads carried at the back of the body are close to the vertebral column.

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This is why backpacks are recommended as a healthy manner of carrying loads. Unfortunately, not many of tourists use such a kind of carrying loads. Passengers met in the vicinity of Cairo railway station did not use suitcases, whether held in hand or pulled on wheels. It looks like they traveled for shorter distances or they did not possess suitcases.

In some professions the injury prevalence occurs even around 20 % of all workers (firefighters).[8] Several studies, as mentioned earlier, showed that biomechanical consequences of improper approach to the load carrying behavior could be serious. People should be taught proper handling of loads. This could be done during"physical education" / "sport" classes of children and youth at schools. To do so, teachers should be prepared in order to teach this problem. Managers and other higher level personnel should teach workers how to handle loads. Author of this article several times seeing workers who adopted wrong body posture while lifting a load came closer to them and taught them proper body posture.

The best way to fix the problem of knowledge of handling a load is to teach students at the "biomechanics" classes during the fields of studies "physical education", "sport", "tourism and recreation", "ergonomics", "management" and other at the higher education institutions. Then graduates as teachers or managers should teach their students or subordinates.

## Conclusion

A problem of handling a load should be taken into account during different fields of studies, during classes at schools and during giving instructions to the employees.

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## Conflicts of interest

The author declares that there is no conflict of interest.

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