# Make your walking free!

"It's not the weight that holds you but the way you carry it" (Lou Holtz)

## Sharpack - Harness for preventing the fatigue caused by backpacks

Sharpack adopts an innovative support system for carrying the backpack that is a revolution for the outdoor world and potentially also for school, where the backpack load can be a threat for the back of children.

In the beautiful outdoor world many players have being continuously looking for the best way to get lighter materials and the technical solutions in order to make it easier and pleasant the mountain activities. As relates backpacks the research has been mainly oriented toward lighter materials and the optimal load distribution usually acting on the classical features like shoulder straps, hip belts and back structure.

Sharpack adopts a support harness consisting of two lateral straps extending so as to wrap and slidingly pass through the lower portion and respectively the upper portion of the backpack body through some belt-guide elements associated with the backpack body itself and connecting at the central thoracic region of the user.

This system lifts the bottom of the backpack and reduces the load on hips and back.

This lifting effect prevents the fatigue of carrying heavy backpack for long trekking.

The system was tested on weights up to 10 kg and the feeling is to carry half of it!

## A short account about the impact of backpack load on musculoskeletal system

There are many studies analysing the impact of the backpack load on the musculoskeletal system and on posture and gait cycle (gait analysis).

Here are the main injuries caused by the load:

- Paresthesia: A neurological disorder, a sensation that goes away once the cause, usually a sustained pressure, is relieved.

- Injuries to the knee and ankle. This is an indirect load effect of a backpack that changes the gait parameters mainly with the increased cadence and speed or number of steps per minute.
- Blister development on the feet is the only direct injury linked to backpack loading as a result of the increased horizontal braking forces induced by the additional loading;
- Back pain, as a result of increased spinal loading that takes to a double reaction, 1. changing spine curvature to induce spinal lordosis, a condition where the lumbar spine curves convexly (in order to shift the body's center of mass more anteriorly) but this condition increases torsion and shear in the spinal discs and 2. increasing forward lean so that the COM of the combined body and load shifts to be more centered over the lower limbs. Both the effects act on the load at the lumbosacral joint and increase possibility of back pain.

  As relates the gait analysis (the study of the way a human walks - the human gait cycle is described as the patterned sequence of leg propulsion to create forward movement of the body) the load impacts as follow:
- Altered Posture. The load reaction can be a higher hips and trunk rotation, that is also a normal trend with an inclined terrain.
- Human Gait Cycle. Cadence, stride length, step length, velocity, stance, and swing time + knee flex, pelvic rotation, vertical oscillation of COG (center of Gravity).

  The Body reacts to the load in order to counter balance the weight and to keep an effective and functional posture for the body motion.

## Main carrying systems of backpacks

Many carrying systems were developed for backpacks in order to face the main load problems, with different methods employed by people of different rural areas or for outdoor or military purposes.

I'll give a brief view of these systems in order to compare the system adopted by Sharpack.

Here are the main systems:

- **Suspension system**:


This system was invented by prof. Lawrence Rome in 2006.

The principle is that the objects inside the backpack need to stay still for avoiding an increased load with their movement.

A frame with elastic elements is applied to the backpack in order to get a suspension effect of the load. The system reduces the force created by the load moving vertically thus reducing the fatigue on shoulders and back. The structure anyway may result to be bulky and heavy.

**Counterweight**:

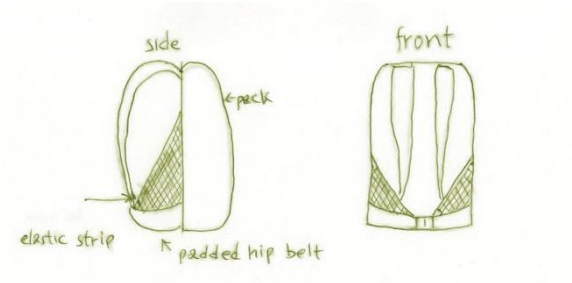
A double pack with weight distributed in both the front and back of the body.

One of the main advantages of the system is a closer to normal posture and a smaller increase in forward lean but there are also big disadvantages like being burdensome to put on and remove, limited field of vision in front of the body, limited ventilation.

- **Tumpline**:

This is a Nepalese method of carriage with a sling formed by a strap slung over the forehead used for carrying a pack on the back (pressure is alleviated on shoulders and hips). This system is very efficient and Nepalese porters are able to carry over 100% of their body weight. This method anyway is quite uncomfortable for outdoor and increases loads at cervical and lumbar vertebrae.

- **Extended Hip Belt**:

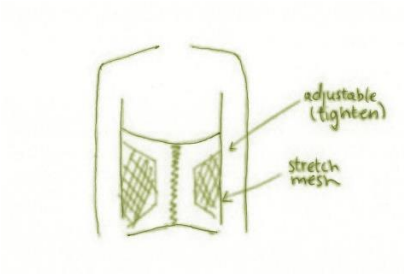



The extended hip belt is meant for changing the load distribution from back and shoulders to hips. A similar role is played by the lateral stiffness rods of modern backpacks that can transfer up to 14% of load from back and shoulders to hips. The counter part of this system is a decrease of air flow and heat dissipation.

- **Pivoting Hip Belt**:

A flexible hip belt that enhances pelvic rotation and reduces shock from rough terrain. The single point between hip belt and backpack can result anyway in moving parts and a less durable structure.

- **Patuka**:




This is a piece of cloth that is wrapped tightly around the abdomen of Nepalese porters (not part of the backpack) and is meant to support the spine by increasing intraabdominal pressure. The disadvantage is the decrease of air flow and heat dissipation.

- **Maporto**:

It is one of the most recently invented systems (together with the Free-Back). Two bent aluminium tubes attached from the bottom to the hip belt and from the top to the shoulder straps take the weight of the backpack off the shoulders to the hip belt. The patented system can be attached to almost any backpack. This system was thought by a polish inventor in 2020 and was awarded at the Ispo of Munich in 2022. It seems to be effective even with heavy weights. The against part with the system is being an external device that could be not much comfortable for more agile mountain activities.

- **Free-Back**:

The system consists of an external hip belt with a fixed rear preformed base where the backpack is placed. The weight is completely sat on the base and the load turned on the iliac crests. This system takes off the load from back and shoulders but the disadvantage may be the same load on the iliac crests and being an external device.

**Sharpack and the harness for preventing the fatigue caused by backpacks**

Given the previous overview of the most known carriage systems, I'll show now what's new with the system adopted by Sharpack.

The simple and effective system adds another support element, the chest.

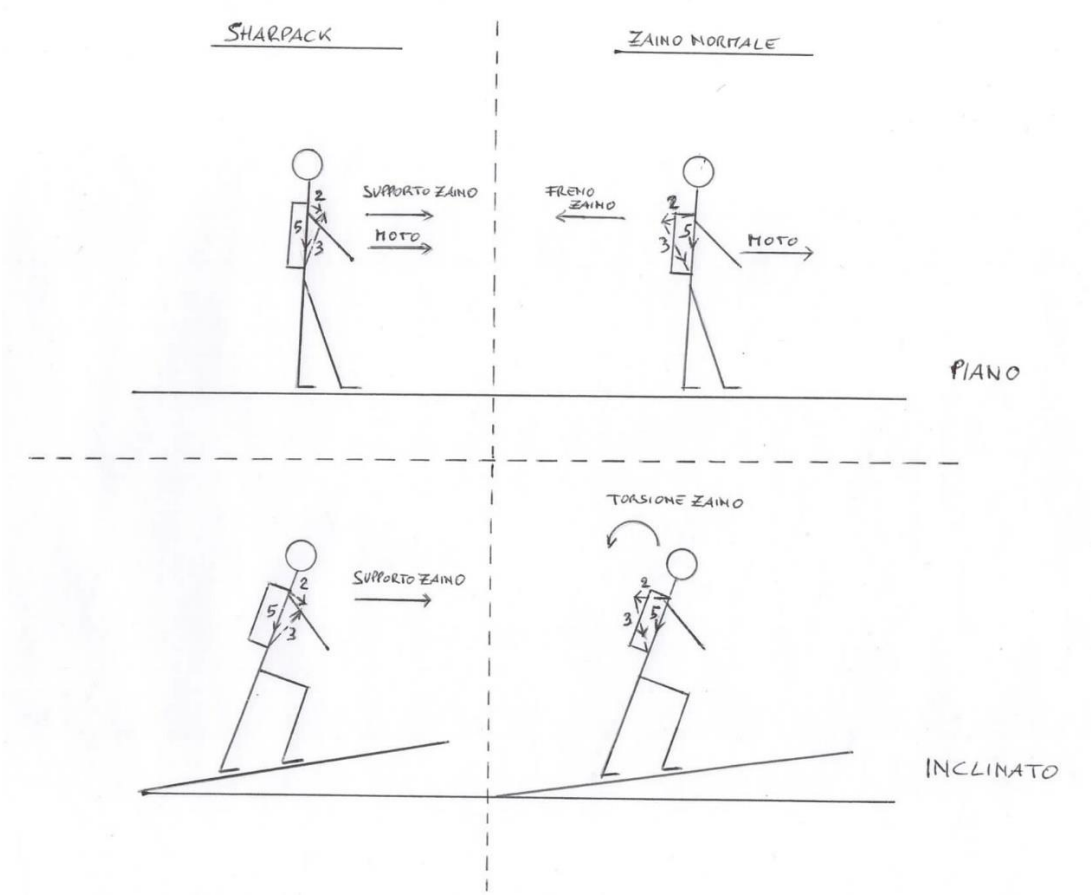
Thanks to a harness fixed to the backpack the load is taken from the bottom of the backpack to the chest by closing the central chest loop.

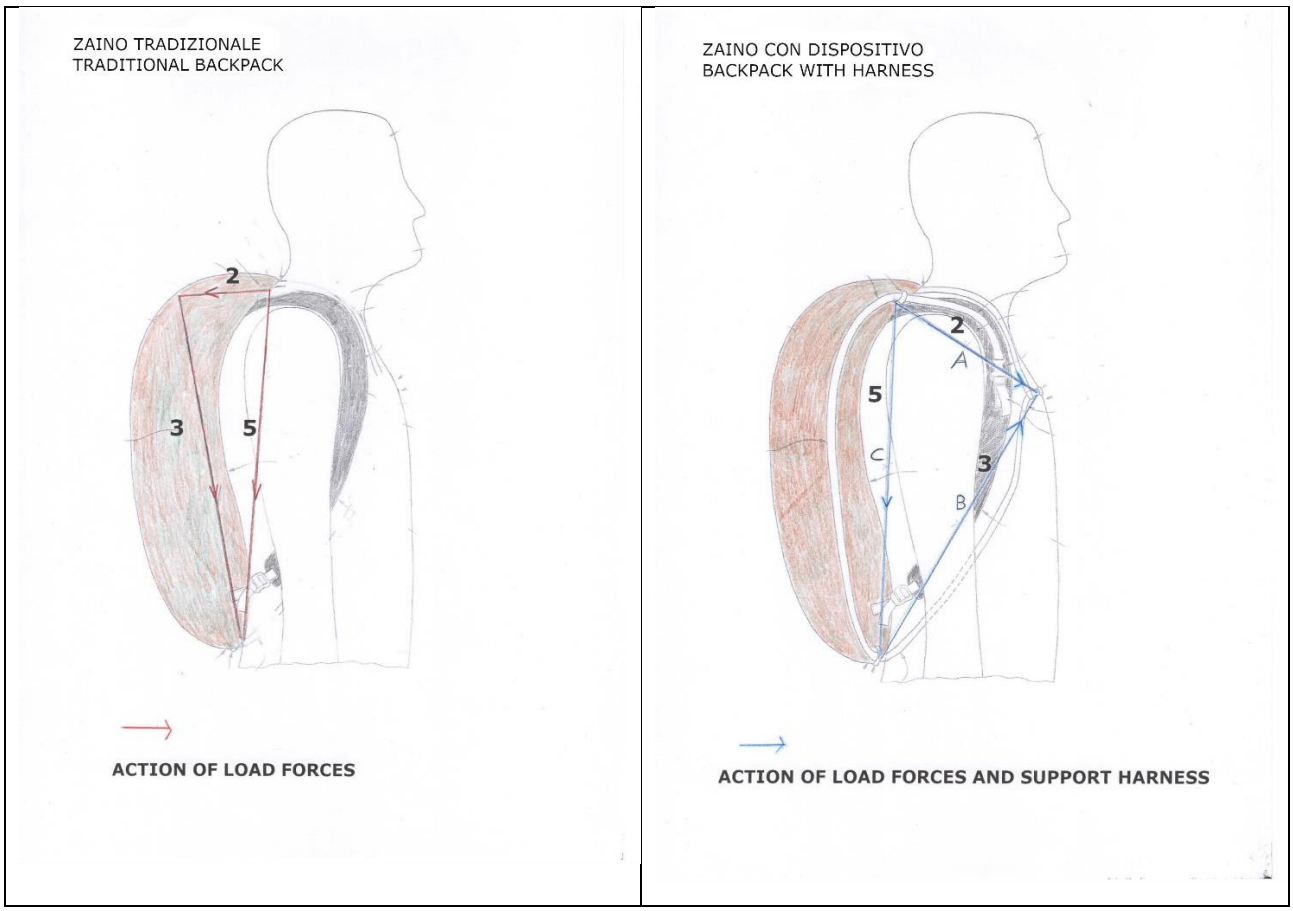
The idea comes by the use of the thumb rings that some backpacks have on the upper part of the shoulder straps in order to lift the load of the bottom of the backpack when the user is tired with the load. The harness is properly applied to the backpack in order to give the same relief and it has some effects on posture and the gait cycle.

The innovation consists on passing from the classical method of the load on the hip belt or iliac crest to a chest based traction.

In order to better understand the system, let's have a look at the model drawn here below showing the carrying system for Sharpack in comparison with a traditional one.

Load forces on a backpack.



The weight is taken off from the hips and transferred to the chest/shoulders loop.

On a classical system the load draws behind (vectors 2+3), in the opposite direction of movement and this turns into a torsion of the lumbosacral joint (with consequent spinal curvature alteration and shear at the lumbosacral joint).

With Sharpack the load (vectors 2+3) is drawn from the front in the same direction of movement.

In a classical backpack the load 2+3 (50% of load) draws behind, in Sharpack the same load pulls in front. Besides, in a classical backpack the vertical load, vectors 3+5, is on back/hips, while in Sharpack the vertical load is the vector 5 only, with an estimated load reduction of 40% on back/hips.

There are some important similarities between Sharpack and the Tumpline system but Sharpack doesn't have the disadvantages of Tumpline. The common point is that the two systems do not offer a simple support point to load the weight (like hips and shoulders for the traditional backpack) but they also supply a traction system that is the forehead for Tumpline and the chest for Sharpack, two elements of support and traction in the same direction of movement.

The main Advantages of the Sharpack system are the following:

- Pressure and effort on hips is much reduced. The load is hold among chest, shoulders and higher part of the back thus reducing the load on the lumbosacral joint and leaving a high freedom to the leg movement.
- The chest loop that holds the load obtains a decrease of torsion and shear in the spinal discs thus reducing the back fatigue and pain.
- As the load is hold in a high position, the system reduces the force created by the load moving vertically thus reducing the fatigue on shoulders and back (an effect similar to the suspension system). A reduced oscillation is also good for going downhill. This last one is a very important point as descent in mountain is at least as important as ascent.

## Gait Analysis

I could have some tests in Lab with a sophisticated treadmill (Walker View) giving all possible parameters of the Gait analysis. The aim of the research was to compare the behaviour of the gait analysis with a normal backpack and the behaviour with the Sharpack system. On the gait cycle there were some expected results due to the effect of load and some results depending on the specific system.

Naturally the body has to counterbalance the introduced load to maintain posture for an effective movement forward and the effect in the gait cycle and kinematic data is an increased cadence and velocity of walking, larger hip flex, etc.

The not expected results depending on the Sharpack system are: 1. On the inclined terrain, a higher acceleration of posture compared to a normal backpack, with increased stride length and COG oscillation. The higher mobility suggests that Sharpack brings a boost on walking, probably linked to the above mentioned forward traction.

2. On the plain terrain posture is instead normalized, that is the gait parameters with Sharpack are closer to the walk without a backpack compared to the ones of a normal backpack. 3. On the inclined terrain (at 12% incline) Sharpack gives higher forward lean, effective to load carriage (similar to Tumpline). 4. The load with Sharpack is more balanced.

## Sharpack and the use of trekking poles

The poles are almost a must for trekkers, as they can reduce up to 22% the forces at knee and ankle level by means of an efficient posture and their support to carry the weight through arms/shoulders and chest.

Given the support already taken by Sharpack, I wondered if the trekking poles were still useful. In my experience I would give the following answers:

As Sharpack takes the load at chest level (turning there a 30% of bp weight), the poles turn out to have a synergic effect. When going uphill the weight that Sharpack takes to chest and shoulders is transferred down to the ground through the poles. On plain the utility is reduced as relates the support to hips because Sharpack already gives that.

Downhill the harness of Sharpack holds the load upward and hips are not pressured by its oscillation so the poles play a minor role. But hiking poles still reduce the load of ankle and knees and they help to increase stability.

Their use is still advised and uphill the effectiveness of Sharpack combined with them is even higher.

## Conclusions

I'm happy to suggest this new way of carrying the backpack.

You will appreciate the freedom of movement on legs that are not pressured by the load on hips and you will come back from a walk with less pain in legs and back.

My aim is not charging more weight compared to other backpack systems but carrying a reasonable weight for a trekking experience more efficiently. The best contest in order to enjoy this system is a mix of up and down hills on mixed terrain with rocks.

Dolomites are a good example.

Of course the weight can't be eliminated but the less fatigue you get is clear.

It's not the weight that holds you but the way you carry it!

References:

1. "It's not the weight that holds you but the way you carry it" (Lou Holtz)
2. "Improved Backpacking Load Carriage System". A Major Qualifying Project submitted to the Faculty of Worcester Polytechnic Institute (Delaney Cassidy, Emma Healey, Kimberlee Kocienski, Ben Pulver, Advisor: Professor Brian J. Savilonis)

| Advantage | Impact | Suspension system | Counterweight | Tumpline | Pivoting Hip Belt | Extended Hip Belt | Patuka | Sharpack | Rilevance on Sharpack |
|---|---|---|---|---|---|---|---|---|---|
| Normalized spine curvature | Normalized posture | | x | | | | | x | |
| Smaller increase in forward lean | Normalized posture | | x | | | | | on floor | |
| Increased forward lean and reduced spinal loading | Induce Forward Lean | | | x | | x | | inclined | |
| Allows for frontal plane rotation | Reduce Physical Fatigue | | | | x | | | x | |
| **Counter moment of force created that should reduce the shear force on the lower back (lumbo sacral joint)** | Reduce Physical Fatigue | | | x | | | | x | estimated 40% less |
| **Increased comfort in hips** | Reduce Physical Fatigue | | | x | | | | x | high |
| **Improved energy efficiency (reduce spinal loading, back pain, fatigue)** | Reduce Physical Fatigue | | x | x | | x | x | x | high |
| Greater range of trunk motion in early phases of gait cycle | Reduce Physical Fatigue | | x | | | | | x | |
| Minimize exertion of spinal muscles | Reduce Physical Fatigue | | | x | | | x | x | |
| Provide shock absorbtion | Reduce Vertical Load | x | | | | | | x | |
| Reduce oscillating load | Reduce Vertical Load | x | | | | | | x | high |
| **Alleviates pressure on shoulders and hips** | Optimize Distribution | | | x | | | | x | Takes load off from hips |
| Smaller displacement in COM (less impact in gait parameters) | Optimize Distribution | | x | | | | | x | |