New ergonomic backpack lightens the load

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An MBL (Marine Biological Laboratory) biomechanics expert has invented an ergonomic backpack that uses rubber bands to reduce the effects of heavy loads on shoulders and joints and permits wearers to run more comfortably with heavy loads.

The backpack's design, which suspends loads using bungee cords, reduces the energetic cost of carrying weight such that users can carry 12 more pounds in the suspended backpack than in a traditional backpack. The suspended backpack could reduce the risk of orthopedic and muscular injuries to children, emergency workers, and others who use backpacks to carry loads.

Lawrence C. Rome, a University of Pennsylvania biology professor and a Whitman Investigator at the MBL, where he spends his summers studying muscle in fish and frogs, and two colleagues, describe the design of and the mechanics behind the Suspended-Load Ergonomic Backpack in the December 21 issue of the journal *Nature*.

With traditional backpacks, the mass of the backpack, which is typically attached tightly to the body, must undergo the same vertical displacement as the hip, which moves up and down 5 to 7 centimeters during walking. As a result, the peak forces exerted on the body by the load can be twice as high when walking, and three times as high when running, as when the backpack is not moving, exerting extreme forces on the wearer's shoulders and joints.

By using stretchy bungee cords, Rome's ergonomic backpack suspends

the load and allows it to stay at a nearly constant height from the ground while the wearer walks or runs. This reduces the vertical displacement of the load and the resulting dynamic forces exerted on the body by a remarkable 82 to 86 percent. The reduction in dynamic force is easily felt, says Rome, and has practical consequences. "An immediate application would be to use it in backpacks carried by schoolchildren, a well known cause of musculoskeletal injury and recognized international public health problem."

Perhaps the most remarkable aspect of the backpack is that it permits wearers to run far more comfortably with heavy loads. "Being able to move at relatively high speeds is crucial for many professions (firemen, first responders, disaster relief workers, and police) as well as in some athletic competitions and recreation," says Rome. "If you have ever tried to run with a heavy backpack, it is almost impossible because of the large shocks to your knees and ankles. What is striking about our ergonomic backpack is that one can feel the 86 percent reduction in force with each and every step."

Rome and his colleagues also found that the suspended backpack's reduction in forces exerted on the body reduced the metabolic cost of carrying a load, allowing a substantially heavier load to be carried. The lower metabolic rate allows the wearer to carry 60 pounds in the ergonomic backpack for the same energetic cost as 48 pounds in a normal backpack. "The reason for this reduction in metabolic rate is that the suspended backpack reduces the accelerative forces during the more energetically expensive phase of walking, which is when both legs are simultaneously in contact with the ground and performing mechanical work against each other," says Rome.

Rome has formed a company called Lightning Packs LLC to further develop and commercialize the backpack. He and his colleagues will be focusing on reducing the backpack's weight and making a smaller

daypack version.

Source: Marine Biological Laboratory