

Notes

- The tumpline/basket carrying system reduces the degrees of freedom of the head-neck segment, but it is very easy to unload in emergency, differently from the rucksack. This makes it preferable in dangerous parts of the trekking. Most of the porters use also rucksack/like shoulder straps attached to their doko when descending with a lightweight or zero load.
- Sherpas, being the higher cast in that region, work today as guides for medium altitude trekking and as porters for extreme climbing.
- During an informal meeting, Dr Ashok Bajracharya, Head of the Department of Orthopaedic Surgery at Bir Hospital, Kathmandu, told us that porters do not seem to be susceptible of carrying-related spinal problems, despite previous researchers (Jager, H. J., Gordon-Harris. L., Mehring, U. M., Goetz, G. F. & Mathias, K. D. 1997 Degenerative change in the cervical spine and load-carrying on the head. *Skeletal Radiol.* **26**(8), 475-81) found degenerative changes in the cervical spine of head-loaded porters.
- Inspection of heart rate records suggests that porters exhibited a very constant performance during the working day (6.6 to 7.8 hours/day), irrespective of the altitude, and that the recovery/resting HR increases during the (uphill) working day.
- A deterministic strategy in managing the resting periods is apparently undetectable. A potential candidate as a determinant, particularly on very steep tracts, is peripheral fatigue. Hip and knee extensor muscles are likely to operate close to the maximum capacity when lifting such additional mass.
- To better appreciate the effort of Nepalese porters, we quote a paper by Yu & Lu (The acceptable load while marching at a speed of 5 km/h for young Chinese males. *Ergonomics* **33**(7), 885-90, 1990) where 20 kg was found to be an acceptable maximum load for marching 7 hours a day at a speed of 1.39 m/s on level terrain and normoxia.

- In the Khumbu Valley the energetic supply is such a problem (the inhabitants still use to dry and burn yak excrements) that, in order to get wood for heating and cooking, exhausting loaded journeys are conceivable. Our guide told us that people from Namche Bazar (3490 m asl) travel unloaded downhill (-22%) to the Hillary Bridge (2800 m asl), then uphill (+22%) unloaded to the same altitude of Namche on the other side of the valley. There they act as woodmen and get 45-50 kg of wood, descend back to the river and ascend finally back to Namche, loaded (within the day). From the metabolic data obtained in the present study (45 J/(m_{vert} kg) uphill and 11 J/(m_{vert} kg) downhill) it is possible to calculate that, considering the low efficiency of the local stoves, the overall energy balance is still positive but without a great margin.
- Himalayan porters' specialization developed similarly to the evolution of vehicles, where most recent cars are more powerful and more economical, for almost the same body/engine size, than the ones built a few decades ago.