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**Health impacts of pedestrian head-loading: a review of the evidence with particular reference to women and children in sub-Saharan Africa.**

**ABSTRACT**

Across sub-Saharan Africa, women and children play major roles as pedestrian load-transporters, in the widespread absence of basic sanitation services, electricity and affordable/reliable motorised transport. The majority of loads, including water and firewood for domestic purposes, are carried on the head. Load-carrying has implications not only for school attendance and performance, women's time budgets and gender relations, but arguably also for health and well-being. We report findings from a comprehensive review of relevant literature, undertaken June-September 2012, focusing particularly on biomechanics, maternal health, and the psycho-social impacts of load-carrying; we also draw from our own research. Key knowledge gaps and areas for future research are highlighted.

**INTRODUCTION: Women and children as head-loaders in Africa**

In urban and rural Africa, wherever transport services are deficient or unaffordable for households, much everyday transport work is achieved through head-loading. Water and fuel are among the most commonly carried loads, even in urban areas where piped water and electricity are often absent; other items regularly carried include agricultural produce and groceries. Domestic load-carrying, as a low-status activity, is regarded culturally as a 'female' activity in most African societies (Malmberg

Calvo, 1994:9; Barwell, 1996:25, 51; Avotri and Walters, 1999; Porter 2008). Boys over about 15 years rarely carry domestic loads such as water and fuelwood (Doran, 1990:30; Malmberg Calvo, 1994:28; Potgieter et al., 2006:15), although men may work as porters. The burden, in time and effort, thus falls disproportionately on women and children.

The role of African women in portage is remarkable: they may spend over 4 hours per day solely on transport (Philpott, 1994). Leyland's review of African surveys (1996) suggests that women typically account for about 65% of all household time spent in transport activities and 66-84% of effort, undertaking 71-96% of all domestic travel. Doran (1990:11) refers to women's 'normal' loads of 25-35kg, 'though loads of up to 60kg have been reported'. The most common load across Africa is probably the 20 litre water bucket, but many women are pregnant and/or carry a baby on their back in addition to their load. In a 5-village traffic-survey in Ghana, the heaviest load weighed was 63kg of fuelwood being carried by a woman, in addition to a baby on her back, over a distance of 8km (Porter et al., 2011). Key papers by Doran (1990) and Bryceson and Howe (1993) drew on village-level transport surveys and research into gendered labour patterns to reveal the predominance of women in rural household transport across many African societies; their findings are regularly reiterated in recent literature, without recourse to further primary data collection. The ensuing development literature has focussed primarily on the implications of head-loading for women's time-poverty, rather than on potential health impacts, a point recently stressed by Sorenson et al. (2011), in the context of women's water-carrying.

While women's head-loading role is well established, children and young people's domestic transport work has received little specific acknowledgment. One rare exception is Malmberg Calvo's (1994) review of four World Bank-funded village-level transport and traffic surveys, which endeavoured to distinguish children's contribution but were restricted by lack of data disaggregation by age/gender in the original studies. Studies of child labour rarely focus specifically on load-carrying, though heavy loads are identified as one of the potentially hazardous agricultural tasks experienced by children in West Africa's cocoa-producing areas, possibly exposing them to injury and illness (Mull and Kirkhorn, 2005). Young people's contribution as urban load-carriers is noted in studies of teenage girls working as porters (*kayayoo*) in Accra, Ghana (Agarwal et al., 1994; Grieco et al., 1996; Awumbila and Ardayfio-Schandorf, 2008).

Research in five south Ghanaian villages (Porter, 2002; Porter et al., 2007, 2011) provided information on the scale of load-carrying by women and children through traffic surveys and counting/weighing head-loads along farm/market routes. Under 18s were found to undertake over a quarter of all load-carrying journeys, transporting loads of up to 36kg (girls) and 39kg (boys). Often girls and younger boys also carried several loads of water daily to their homes. Other common head-loads for both children and adults were cassava, maize, vegetables, charcoal and (often the heaviest load) firewood. From the age of 10, both genders regularly carried large loads of firewood up to 10km for commercial purposes. Even younger children, accompanying their mothers to the market to sell firewood, carried their own small loads. Parents explained how load weights are increased as the child grows older and stronger: girls aged 15 (slightly older for boys) are expected to carry a full adult's load

(up to 70 kg). This practice of building loads carried over early stages of the life course suggests careful body management: what Jackson (1997) refers to as building up body capital. It also indicates some parental acknowledgement of the risks associated with carrying. Hoque et al. (2012), albeit working outside our focus region (in Bangladesh), find injuries are commonest amongst young farmers or unskilled day laborers; specifically those who attempt to engage in head-loading without gradual habituation.

In a more recent study in Ghana, Malawi and South Africa, Porter et al. (2012) observed very substantial head-loading by children (N=1000 in each country). Over three-quarters of boys and girls (aged 7-18y) surveyed in Ghana had carried water in the week preceding the survey, and over 90% of those living in rural settlements (suggesting higher rates of carrying than Multi Indicator Cluster Survey MICS-3 data for Ghana, reported by Sorensen 2011:1524, which puts child - gender undifferentiated- water carriers under 15y at 15.6% and women plus children –age undifferentiated - at 22.2%) . In Malawi, over 70% of girls and 30% of boys had carried water in the preceding week, and the corresponding figures for South Africa were 32% (girls) and 23% (boys) (substantially higher than the MICS-3 data for Malawi of only 6.9% for children, *ibid*; there are no comparable data for South Africa). However, children said the *heaviest* loads they usually carried were firewood: almost 50% of children surveyed in Ghana had carried fuelwood on at least one day in the preceding week, as had over 20% of all children in the other two countries. Other head-loads frequently transported by girls and boys in this study included domestic refuse and agricultural produce.

Children's high load-carrying burdens also emerged from Hemson's (2007) work on water collection in four remote South African villages, where children aged 5-17 years - especially girls - carried more water (mostly by head-loading, sometimes by wheelbarrow) even than women. Unfortunately, questionnaire data presented do not disaggregate between transport modes (nor by gender) but revealed negative impacts of the load-carrying on schooling (lateness/missing school, tiredness in class, delayed progress), themes also highlighted in Ghana (Porter et al., 2011; Porter et al, 2012), and on health and wellbeing. Just under one-third of those interviewed spent 21+ hours per week fetching water, a group which 'appears particularly vulnerable to experience of fatigue and poor health' (Hemson, 2007:323). Among the children who felt their health had worsened over recent months, over three-quarters were involved in water collection for over 14 hours per week. However, Hemson also points to children's health problems associated with water contact diseases such as bilharzia.

To summarise, the available literature (including our own previous research) indicates that large numbers of women and children (and, to a lesser extent, men) in Africa regularly carry heavy loads on their heads for domestic and commercial purposes. However, while some authors have speculated on the associated impacts on the health and well-being of head-loaders, to our knowledge there is no comprehensive review of the evidence. This paper aims to fill this important gap. Below, we describe our systematic review procedures before outlining the current state of knowledge in each of the relevant disciplines. We end by highlighting some of the gaps and priority areas for research and action.

## **METHOD: Comprehensive Literature Review**

A comprehensive literature review on the health impacts of head-loading was carried out in June - September 2012, using MEDLINE (via OVID, incorporating Web of Science and BIOSIS) and Web of Knowledge [see electronic file for further detail]. No date limits were set on the search, but the search was restricted to English-language papers only. An initial search for 'head[-]loading' identified 25 papers in Medline, only 6 of which referred to the practice of carrying heavy loads on the head. It was therefore necessary to broaden the search to include papers in which a synonym for 'carrying' appeared in close proximity to the word 'head'. The phrases 'axial load' and 'load carriage' were also used to search for papers of possible relevance. It proved necessary to search for concepts using keywords, as well as the related MESH concepts, due to coding inaccuracies.

To be included, papers had both to refer to humans and to include one or more of the key terms 'head', 'neck' or 'cervical' (in relation to the spine) . In order to further refine the search, MESH terms were used to exclude papers referring to cadavers, aviation, vehicles, sports (except walking), oncology, ophthalmology, dentistry and orthotic devices.

Once the results of the searches had been combined and duplicates removed, the remaining 5773 papers were hand-searched for relevance. Only papers that reported specifically on head-loading, and where head-loading data could be distinguished from other forms of load transportation were included. (Several papers were excluded on that basis; for example, Nkiru and Meludu's (2008) recent study of transport of agricultural produce to market in Ibadan, Nigeria, which does not distinguish between

the health impacts of different modes of transport, i.e. carts, wheelbarrows, head-loading.) This process resulted in 40 relevant papers. Geographical region was not a selection criterion for our searches, but the vast majority of relevant papers refer to sub-Saharan Africa. Other relevant papers and books, identified from reference lists and bibliographies, were also included bringing the total to 88.

## **RESULTS: Health implications of head-loading**

Five major components of potential harm to health and well-being were identified from the review: energy costs of headloading, long-term bio-mechanical impacts (musculoskeletal injury and degenerative changes), risk of acute injury, impacts on maternal and foetal health, and psychosocial impacts (reported pain and social participation). Although there is some overlap between these, each is considered below in turn.

### **a) Energy costs of headloading**

Because heavy and regular load-carrying is predominantly a feature of impoverished populations (i.e. those without basic services, infrastructure and/or transportation, or livelihood alternatives), one possible health risk associated with load-carrying is an energetic one. Individuals who may already be under-nourished might suffer negative energy balance if they carry heavy loads, a situation associated with a number of health problems including compromised physical and cognitive function (Kurpad et al, 2005), impaired immune function (Black et al, 2003) and, as we discuss below, impacts on reproduction. However, adequate assessment of energy balance is difficult to achieve because of both the well-documented difficulties of accurately



assessing energy intake (Huss-Ashmore, 1996), particularly in populations where food is typically eaten from a common bowl, and the energetic variability in ‘real’ load-carrying practices, which are intermittently combined with other highly energy-intensive activities undertaken by African women. As a result, most studies (including those reported below) have been limited to energy expenditure only, under controlled treadmill conditions.

The evidence is equivocal, even when merely focusing on treadmill data. Two studies in the 1980s presented head-loading as an energy-efficient means of transporting goods. Maloiy et al. (1986) observed that it is not uncommon to see Kenyan Luo women carry loads equivalent to 70% of their body mass, and that both Luo and Kikuyu women could carry loads of up to 20% of their body mass without increasing their rate of energy consumption. Maloiy et al. suggest (p.669) that ‘some anatomical change has occurred, as a result of carrying large loads since childhood, which allows these women to support small loads using non-metabolizing structural elements’, but this conclusion is based on studies with just five women (three head-loading Luo; two head-strap/back-loading Kikuyu). Charteris et al. (1989), however, examined treadmill data for 150 Xhosa women agricultural labourers (randomly selected and from a wide age-range) and confirmed that the energy expended per unit of load carried was constant, at least until 20% body mass loads were being moved.

Lloyd et al. (2010c, 2011) compare their own findings from work with 24 South African Xhosa women in their twenties with this earlier work of Maloiy et al. and Charteris et al., which was based on very small sample sizes. Lloyd et al. point out that it is possible to select a subset of women from their own data set who achieve

remarkable levels of energy economy and argue that this 'is not altogether unexpected but suggests that the "free ride" hypothesis is not a generalizable finding, when tested with larger more representative samples of African women' (2010c: 614). Four of the five most economical head-loaders in their own group are women with no experience of head-loading, which leads them to conclude that structural changes to the spine associated with early and prolonged exposure to head-loading are unlikely to provide the explanation for the energy efficiency that Maloiy et al. postulated (ibid:614).

Drawing on a series of studies with both Xhosa women and nine British women back-carriers, Lloyd et al. (2010c,d) also show that, in general, head-loading may be no more economic than carrying loads in a back-pack. Furthermore, they are able to comment on earlier arguments regarding the possible significance of body composition for load carrying economy (Lyons et al. 2005), with particular reference to the suggestion by Jones et al. (1987, based on an assessment of eight Mandinka women) that the remarkable economy observed in some head-loaders is due to low body fat (i.e. obese African women do not exhibit this same economy). To the contrary, Lloyd et al. (2010c, d,e) do not find a strong relationship between the leanness of the women in their data sets and those who exhibit some form of free ride. Rather, they conclude that there is significant variation in load-carrying economy and this is regardless of whether a head- or back-carrying method is employed. They thus propose that there may be different factors aligning in individuals to influence economy rather than a single set of factors: this suggests the need for further research to establish the nature of the factors and how they interact in individuals (Lloyd et al. 2010c, d).

## **b) Long term biomechanical [musculoskeletal] impacts**

Of all the possible health impacts of head-loading, it is the biomechanical ones that have received most attention from researchers. The earliest work in this area came principally from the transport and development studies literature. Load-carrying was not usually the primary focus of these studies, but the findings cumulatively drew attention to potential linkages between heavy loads, livelihoods and health, particularly for girls, pregnant women and elderly women (e.g. Carr, 1983, cited in McCall, 1985; Sims, 1997, cited in Jackson and Palmer-Jones, 1998; Avotri and Walters, 1999). Bryceson and Howe (1993) reference a range of potential short- and long-term impacts of load-carrying in the literature, including Kenyan medical sources showing high incidence of backache among Maasai women and treatment of ‘Kikuyu bursa’ (also known as tumoral calcinosis, a condition affecting the lower spine and sometimes the hips). Likewise, a WaterAid pamphlet (1996) suggests that carrying heavy water loads has especially serious implications for girls, given their physical immaturity; notably damage to head, neck and spine. It notes (without supporting evidence) that deformity of the spine in extreme cases can lead to problems in pregnancy and childbirth. Unfortunately, few transport/development studies refer specifically to the health impacts of load carrying on children and young people. Studies of girl porters in Accra (*kayayooos*) tend to refer to their ‘many health problems’ (Agarwal et al., 1994:8), but focus more on social relations (e.g. Awumbila and Ardayfio-Schandorf, 2008).

In contrast to these rather anecdotal reports, there has been more recent clinical and biomechanical research into the musculoskeletal impacts of head-loading, which we review below. Unfortunately, many of these studies are limited by small sample sizes, and a cross-sectional approach which makes it difficult to establish causality; moreover, few have considered the differential impacts on children and adults. As relatively few such studies have been conducted in African contexts, studies from Nepal and India have also been included here.

One might expect the association between cervical spondylosis, or degeneration of the neck vertebrae (including the intervertebral disks), and the carrying of loads on the head to be well-documented and straightforward (Mahbub and Laskar, 2006).

Surprisingly, however, Bista and Roka (2008) found the prevalence of spondylosis to be higher in non-porters than porters in Nepal. Meanwhile, a review (Belachew et al., 2007) confirms that studies of cervical spondylosis in African contexts are few.

Those which do exist suggest that clinical manifestations in Africa can be linked to load-carrying but also, in the Rift valley region, to fluorosis (see also Jumah and Nyame, 1994). Citing Shedid and Benzel (2007), Belachew et al. (2007) note that head-loading women may develop degenerative disc disease in the upper cervical spine, with increased incidence of listhesis at a younger age (forward movement of one vertebrae with respect to an adjacent lower one, causing narrowing of the canal and hence possibly inducing neurological deficits or other complications). Joosab et al. (1994) observed significant degeneration of the fifth intervertebral disc space and a straightening of the lordotic curve of the spine among head-loaders in Zimbabwe (n=20 loaders; 25 non-loaders, age-matched, 10-60y; gender not stated). They suggest that head-loading also encourages a shift in the degeneration from the fifth

intervertebral disc space to higher levels. Another study of 35 Sierra Leonians who are professional load-carriers, disaggregated by age and sex, and a control group of non-carriers, (Jager et al., 1997) found a relationship between load-carrying and development of degenerative changes in the cervical spine and consequent narrowing of the spinal canal. The impact of degeneration on the nerves associated with this degeneration could also include numbness and loss of feeling in the arms.

Other key work in this area includes that of Echarri and Forriol (2002, 2005). Their first study (2002) used radiography to compare 72 women aged 24-78y who had headloaded wood in bundles of 25-50 kg over 6-8km for a mean of 12 years, with a control group of 44 women of similar age who were randomly selected from their hospital patients 'outside the orthopaedic service' and were not woodbearers.

However, we are not told why they do not do participate in this activity, which could be influenced by other factors such as socio-economic status (which could affect nutritional status). They reported that women stiffen their necks in order to bear weight, thus developing hypertrophy of the trapezius muscle and other impacts (which may be an advantageous adaptation rather than a cause for concern). In a second reported study (2005) of Congolese bearers, they compare three groups: one carrying light loads [30-35kg], one carrying heavy loads [50-60kg] over short distances, and a control group of non-head-loading building workers. Through the analysis of clinical signs and symptoms and radiographically-determined degenerative signs, they concluded that bearing heavy head-loads, in particular, produces more radiographic degenerative signs (prolapsed discs), neck stiffness and more reported pain than in the control group. There was also a correlation between the number of disc herniations, and increasing age and years of work. However, there is no indication of the gender

composition of the samples (though photographs suggest both men and women were included).

A recent study by Badve et al. (2010) examined prevalence of occipito-atlantoaxial [OC1C2] osteoarthritis in 107 randomly selected male head porters aged 20-60y working at railway stations in Mumbai, India and a control group. The porters carried loads of 30-50kg about 8-10 times per day, over a distance of about 1km, 6 days per week. Radiologic prevalence of OC1C2 osteoarthritis was 91.6% in the study group, compared to 6.8% in the control group. Suboccipital neck pain was reported by 69.7% of the study population but the research found no statistically significant association between presence of radiologic changes and symptoms.

None of the work cited above has considered the anatomical differences between the child and adult spine, or the musculoskeletal implications of head-loading prior to adolescence. Growth plates will respond to regular load carrying and the paediatric spine differs significantly in terms of biomechanics and potential modes of injury when compared to the adult spine: it is more flexible, there will be more injuries without bony fracture and higher incidence of injuries in the mid- rather than the lower-cervical region (Roche and Carty, 2001). There are also important questions to be answered regarding the impact of less well mineralized bone (and consequently “weaker” bones) and dietary deficiencies on health among those who regularly carry heavy loads. Illness history, including TB and febrile illnesses in particular, may affect spinal growth, development and degeneration, but little is known about the relationships between the impacts of nutrition, acute illness and load-carrying on the spine. Based on work with a small sample of women and children head-loaders aged 6-64y (n=39) in South Africa, Geere et al. (2010b:10-11) suggest that individuals

living with HIV may suffer from osteopenia and have a higher risk of fragility fractures and delayed fracture healing; they may also be more vulnerable to injury from regular compressive loading through the cervical spine, but the evidence for this is limited.

Finally, it has been suggested that load-carrying may have *beneficial* impacts on bone quality/density (though this will also be dependent on mineral uptake and bone turnover). Recent research by Lloyd et al. (2010a) on a small cohort of women aged 18-31y (n=32) in South Africa suggests that head-loading 'may offer osteogenic benefits to the spine' (p.189), although this effect was not observed in the subgroup using injectable progestin contraception.

### **c) Risk of acute injury**

In addition to the long-term biomechanical impacts of load-carrying, there is also some evidence to suggest that acute injury, such as metatarsal (foot) stress fractures, especially on rough terrain (Charteris, 2000), and acute injuries to the arm (e.g. Colles fractures of the wrist) and leg bones (e.g. ankle injuries) as a result of falls may impose an extra health burden on load-carrying populations. Kwamusi (2002) suggests fatigue and slippery paths in the wet season as common causes of falls among head-loaders in Uganda, resulting in widespread knee and toe injuries. Serious falls during head-loading can have both severe musculoskeletal and physiological repercussions: Howe (personal communication) recalls that about half the women in the Dhaka centre for the rehabilitation of the paralysed had fallen while carrying a

load; he suggests a tendency among the poor to try to save the (precious) load rather than themselves.

#### **d) Maternal and fetal health**

In the development and transport literature on head-loading, there are several references to possible physiological impacts of load-carrying on risk of miscarriage, foetal development, premature birth and low birth weight. Haile (1989) interviewed 276 female fuel wood carriers in Ethiopia and found the incidence of miscarriage was 16 per cent on average and 44 per cent in the age group 35-44 years, but as Doran (1996:61) notes, it is unclear whether this is higher than for the general population.

Some physiological and occupational health research has considered possible links between load-carrying and pelvic organ prolapse (Boucaut et al., 2008; Jørgensen et al., 1994; O'Dell and Morse, 2008; Slieker-ten Hove et al., 2009; Woodman et al., 2006). Very high prevalence of genital and uterine prolapse has been reported among women of reproductive age throughout Sub-Saharan Africa, including 42% genital prolapse and 6.8% uterine prolapse in the Gambia (Walraven et al., 2001). These conditions can impact seriously on emotional wellbeing (e.g. Wusu-Ansah and Opare-Addo, 2008), but the causal pathways, including load-carrying impacts remain unclear.

Another important strand of research regarding maternal and foetal health concerns energy balance. As noted above, the evidence is equivocal, but load-carrying may impose high energetic costs, which can be problematic, particularly for populations



that are already nutritionally vulnerable (e.g. Panter-Brick, 1992; Taylor, 1995 etc.). Under conditions of low or negative energy balance, there are trade-offs to be made between investing energy in reproduction and energy requirements for other physiological needs (Jasienska, 2003). The resulting temporary suppression of reproductive effort during periods of energy shortage is now a well-documented phenomenon; women in negative energy balance through load-carrying can experience reduced fecundity or ability to conceive. Thus, Panter-Brick (1996) observed seasonally-reduced conception rates among Nepalese women porters, during period of peak load-carrying, while Gibson and Mace (2006) noted an increase in birth rates among Ethiopian women aged 15-49y (n= 1,548) when their water-carrying work was reduced by the installation of new water points. They suggest that this is 'likely to be mediated by improvements in women's workloads, brought about by reducing energetic expenditure on water collection, since women's nutritional levels, breast feeding practices and health do not vary' (p. 7). Moreover, women in negative balance during pregnancy may be less able to carry pregnancies to term and at greater risk of having low birth-weight babies (Pike, 2000; Lima et al., 1999). However, Shaw (2002), in a review of epidemiologic data to investigate whether strenuous work by women in pregnancy in developing countries influences micronutrient status and thereby increases risks of adverse pregnancy outcomes, concludes that current data are inadequate and that further research is required.

Some other studies reporting links between heavy load-carrying and pre-term birth do not specify the causal pathways (energetics or other physiological processes). Such studies include Agbla et al.'s (2006) finding, from a study of 203 mothers that those who carried heavy loads on 5+ days per week were at significantly increased risk of

pre-term delivery, and Bao's (1989) reported associations between heavy load-carrying in pregnancy and increased incidence of premature birth and lower position of the uterine cervix (from a study of 364 women with varied occupations).

Finally, it has been suggested load-carrying in pregnancy may carry extra biomechanical risks. In a recent study of 26 pregnant women in Benin (and a control group), Beaucage-Gauvreau et al. (2011) found that posture modifications associated with trunk displacement led to muscle fatigue and ultimately to musculoskeletal injuries.

#### **e) Psycho-social impacts: Pain and social participation**

One limitation of biomechanical and clinical studies of load-carrying is the lack of clear correspondence between radiographically observed degenerative changes and the subjective experience of pain or impairment. Indeed, in Western contexts, research has uncovered only a slim link between physical exposure in contemporary work environments and lower back pain (Waddell and Burton, 2001), while biomechanical models which attempt to predict forces and the risk of injury from manual handling activities do not correlate well with the actual incidence of pain or injury (Pinder and Frost, 2009). In fact, pain and disability due to musculoskeletal disorders among workers show a much stronger correlation with psycho-social factors, which can act as powerful obstacles to participation (Kendall et al., 2009), although it can be argued that modern work practices in Western contexts have removed much of the detrimental physical exposure, leading to a reduction in (or elimination of) adverse biomechanical impacts (Waddell and Burton, 2006; Brinckmann et al., 1998; IIAC, 2008). For this reason, it has been argued (e.g. Geere

et al., 2010b) that it is important to investigate relationships between load-carrying history (intensity, frequency and duration) and symptoms such as neck or back pain and functional disability, rather than relying on findings from radiographic examination alone.

Such studies, relating perceived pain to head-loading, are however extremely rare. One small study compared subjective perceptual responses to head-loading and back-loading among 32 Xhosa women in their early 20s in Cape Town who walked on a treadmill at a self-selected walking speed with a variety of loads, until pain or discomfort caused the tests to be terminated, or a load of 70% body mass was successfully carried. It found that though back-loading was associated with more *areas* of discomfort, neck pain and discomfort in head-loading was the predominant factor in the termination of tests, independent of head-loading experience (Lloyd et al., 2010b). It also reported neck pain as a major source of discomfort from water carrying among head-loaders (and their mothers and grand-mothers). Two other recent papers, also based on small samples, focus on health implications of domestic water carrying in Limpopo Province, South Africa (Geere et al., 2010a, 2010b). In the first paper, based on qualitative research with 30 children, the authors suggest that since children have lower tolerance limits for physical stress (citing Nuckley et al., 2007), they may be particularly affected by water carrying, with potential impacts on pain, joint mobility, energy/drive, physical endurance, and emotional function. The second paper reported that 20 out of 29 women and children in their sample who head-loaded water reported spinal pain, with a relationship (not quite statistically significant) between weight of water carried and perceived exertion (RPE).

Other work on pain and load-carrying can be found in some of the development and transport literature. Focus groups respondents participating in a transport study in rural Zimbabwe reported a relatively higher incidence of backache, head and chest pains among women than men, which they attributed in large part to head-loading (Mudzamba, 1998:12). In the Ghana five-village study (above), women sometimes referred (in passing) to the backaches and pains that they attributed to load-carrying, for which they self-medicated with various pharmaceutical and local herbal medicines (Porter, 1999). Finally, in the recent study on children's mobility in Ghana, Malawi and South Africa (Porter et al., 2012), children gave detailed personal accounts of their load-carrying journeys and associated impacts: predominantly pain and on schooling. In a survey of 3000 children aged 7-18y in 24 field-sites across the three countries, high proportions of respondents reported incurring pain (principally headache, neck-ache, waist/ back pain) and/or exhaustion from load-carrying in the week preceding the survey: over 70% of those in Ghana, 35% in Malawi and 15% in South Africa. These substantial inter-country variations were associated in part with differing socio-cultural contexts, but also in South Africa with higher usage of draught animals and other non-motorised means of transport. There were also substantial rural-urban differences in each country, related to load prevalence and availability of other means of transport.

In interpreting these figures, however, it is important to note the high background prevalence of musculoskeletal symptoms across all ages, genders and geographical locations (Adams et al., 2006). In Western contexts too, a high prevalence of back pain is reported by children and adolescents (Korovessis et al., 2012). Such back pain is often not regarded as a serious problem, being a short-lived (though sometimes recurrent) experience, not requiring treatment. Virtually nothing is known about the

concomitant psychological symptoms and illness perceptions (e.g. distress, depression) among African head-loading populations, including children; the same applies to possible disabling consequences (reduced participation) of musculoskeletal problems and their psychosocial correlates.

Interestingly, the limited research available suggests that parents rarely view children's head-loading as a problem (Porter et al., 2011). Children are widely perceived as a domestic resource by adults and are required to carry a range of loads for their parents and other family members; according to both the Ghana 5-village study and subsequent study of children's mobility in Ghana, Malawi and South Africa, in rural areas in particular, children simply *expect* to head-load (Porter et al., 2012).

## **Discussion**

This comprehensive review of the literature on the health impacts of head-loading, especially for women and children, suggests some serious areas for concern. Head-loading may be associated with negative energy balance, chronic musculoskeletal symptoms, risk of acute injury, compromised reproductive outcomes, and pains and associated distress. On the other hand, work *per se* may be beneficial for well-being (see Waddell and Burton (2006) on this point in Western contexts), and the potential positive impacts on BMD have not been fully explored.

However, clear evidence for any of these impacts is lacking. In the transport and development literature, which has been influential in drawing attention to issues around head-loading, information on health impacts is usually anecdotal or

speculative. As noted above, health is not the central focus of most of this work (which tends to be livelihood-based). Reports of health impacts tend thus to be based on retrospective accounts, without adequate controls, and do not go beyond painting a very general picture of *possible* impacts on health and wellbeing.

Our review identified several studies that have sought to go beyond this, for example, by using radiography, clinical examination or pain scales to measure the outcomes of load-carrying on various areas of health and well-being. Again, however, most studies are limited by very small sample sizes and often a lack of adequate controls, which make it nigh on impossible to account for a plethora of confounding variables, such as nutritional status, energy expenditure, and illness history, all of which have the potential to impact on skeletal development in children. Moreover, the retrospective or cross-section design of most studies to date makes it almost impossible to establish causality.

A further limitation of the studies reviewed above is that they rarely disaggregate by age, and sometimes not even by gender: these are crucial distinctions to make, both because of musculoskeletal changes over adolescence, and because the social positions of girls, boys, women and men - and thus the psycho-social impacts of head-loading - may vary, not only between, but also within even relatively homogenous populations. Intersections between socio-economic status, gender and age require particular attention outside commercial portage (which is commonly associated with low status): class is often a gendered phenomenon, hitting women before it affects men (Sen et al. 2007; Iyer et al. 2008). Nor do existing studies allow analysis of differential impacts of head-loading according to type of load, duration, frequency or

terrain (weight is sometimes, but not always, included in analyses) or - crucially in African contexts - whether the head-loader is also carrying a child.

In essence, remarkably few of our reviewed studies meet basic scientific standards and there is an absence of studies which satisfactorily combine rigorous scientific methodology with an adequate understanding of the social and cultural context. While transport/ development studies typically engage with the social/economic context, they lack the appropriate methodologically-rigorous tools to establish causal links between head-loading and health impacts. By contrast, the clinical studies cited do not give adequate consideration to the wider socio-cultural context in which head-loading occurs. This is important, firstly because methodological tools must be culturally appropriate in order to yield reliable data (for example on pregnancy outcomes, pain or other psycho-social impacts), and secondly because the meanings associated with particular outcomes are inevitably culturally-contingent. For example, the issue of pain in its diverse forms (e.g. chronic; returning; acute; recalled), its complex associations with ill-health and its inter-subjectivity are highly contingent, and notoriously difficult to unravel (Scarry, 1985; Scheper-Hughes and Lock, 1987). Understanding the *lived experience* of load-carrying goes beyond simply the impacts on physical health and associated pain, to explore, for instance, the wider well-being implications of a very low-status occupation (Porter et al., 2012).

## **Conclusion**

The immediate and longer-term implications of head-loading for health and well-being remain largely unknown. The majority of information available is little more

than anecdotal and has come as a by-product of transport-related research, rather than from studies made with/by health professionals . Given the almost ubiquitous utilisation of women and children as porters to fill the transport gap in sub-Saharan Africa (because of the inadequacy of cheap, regular motorised transport), this is a topic of vital significance to development across the continent. In a carbon-constrained world, the potential to reduce African women and children's pedestrian carrying burden in the foreseeable future may be limited. Research is needed to address the series of significant gaps in our knowledge of the implications of load carrying, to enable appropriate health interventions and make associated policy recommendations. An interdisciplinary approach is needed which brings together research on three specific areas of potential harm: biomechanical (degenerative changes and risk of acute injury), physiological (including maternal health and energetics) and psycho-social (including pain) impacts of load carrying.

Load-carrying is a complex activity which is likely to vary in its short and longer-term health impacts according to diverse variables including load type, weight, carrying distance and speed, topography, on- and off-loading practice and carrier characteristics (gender, body mass, age, health status, health history, footwear). Thus, for instance, while water-carrying has been the focus of some recent attention regarding health issues, data on children's load carrying across three countries (Porter et al., 2012) indicates that water is not usually the heaviest load and that perceived bodily impact of carrying (in the form of sickness) is often linked to particularly heavy loads – firewood, farm produce and building materials – rather than water-carrying. Moreover, different loads have different shapes and are likely to impact differently on the bearer. For instance, a load of firewood carried laterally with the



ends protruding substantially is quite a different load to a 20 kg plastic water container carried vertically, in terms both of the potential for sudden re-distribution of the load (as water 'sloshes'), and manoeuvrability of 'awkward' loads like firewood; significantly, firewood is the load children most commonly associate with falls. Loading-up and unloading procedure may also differ according to the load type, with varying implications for bodily compartment and impacts.

Potential confounding variables are numerous and include illness history (e.g TB, HIV, febrile illnesses), nutritional status and history (longer-term and seasonal variations), energy expenditure patterns (including energy expended on non-load-related activities), body shape, gender (including women's obstetric history), age (including age at which load-carrying commenced), pattern of expertise development in load-carrying and long-term exposure to high fluoride. It is clearly essential to understand the socio-economic, cultural and institutional contexts within which head-loading takes place. Household and individual poverty forms a pervasive and pernicious backdrop to the foregoing discussion and presents parameters within which the following questions will need examination. If head-loading is highly damaging to affected populations, can practical interventions be made at sufficiently low-cost to achieve a reduction in harm? Would this present a new impetus to innovation in, and interventions involving, Intermediate Means of Transport (IMT, such as carts and wheelbarrows)? Or is the question more a matter of establishing parameters for ergonomic guidelines regarding avoidance or reduction of head-loading practices detrimental to health (e.g. guide weights re magnitude and frequency of load in different terrains, at different ages and by gender, optimum speed of movement, carrying distances, loading and unloading techniques, footwear, combination with

other physically demanding activities, recovery time after childbirth etc.), together with appropriate health interventions and associated policy recommendations? What is the real potential for take-up of findings in terms of improved policy and practice? In the unregulated real world in which most pedestrian carrying takes place, IMT intervention could well prove a more fruitful arena for exploration, than provision of ergonomic guidelines. Before we start searching for solutions, however, we need to have a firmer understanding of the nature, extent and impacts of head-loading, especially for the women and children whose lives currently revolve around this practice.

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