Author’s response to reviews

Title: Domestic water carrying and its implications for health: a review and mixed methods pilot study in Limpopo Province, South Africa

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Author’s response to reviews: see over
Dear Sir,

We thank the reviewers for their careful and very thorough consideration of our paper and constructive comments which we believe have allowed us to improve the article. We have addressed each comment below. As the responses to reviewers’ comments have required the addition of a considerable amount of background information, we have altered the title to what we believe will now better reflect the length and content of the paper:

‘Domestic water carrying and its implications for health: a review and mixed methods pilot study in Limpopo Province, South Africa’

Reviewer: David Hemson

Reviewer’s report:

Minor Essential Revisions

1 The reported high level of container/body weight (at about 60%) seems too high as it seems to imply that the average body weight is about 30kg since the container averages 19.5kg. Please check.

The high container/body weight ratio noted is in Table 3, which is inflated because the data includes the weight of water carried for all methods of water carrying which were observed. Methods of water carrying observed included head loading, using wheelbarrows and rolling a container. The ratio in Table 3 remains slightly higher than in Table 4 because of the increased absolute weight of water in comparison to body weight transported by wheelbarrows, (when 4 or 5 20 litre containers were usually carried and on two occasions by small children) and rolling a container, which allowed two very young children (of 6 & 7) to move a 20 kg drum.

Table 4 describes the values for participants using head loading only, and the ratio of container weight to body weight here is 41.4%, consistent with the average weight of participants being 49.55kg as reported in Table 1 and the average container weight for head loading being 19.5 kg (Table 4). This is not exact because the average weight of the whole sample (not just head loaders) is presented in Table 1.

2 Although small, more comprehensive descriptive statistics could give a more rounded account of the sample (e.g. including ages, etc) and provide full details for the work to be replicated.

Age, height, weight and BMI for the sample from whom observational data was gathered are provided in Table 1 and the numbers of children and adults of each gender, as well as the number of children unaccompanied by an adult are now included in the table. Table 2 has been added with additional information on the villages and data collection conducted in each one.

3 There could also be greater explanation for readers not familiar with Newtons to understand whether the forces are particularly great.

The following has been added to the text under data analysis;

‘Force in Newtons (N) is equal to mass (kg) multiplied by gravity (9.8m/s²) such that 1kg is approximately equal to 9.81N [11]. The force generated by an object of a known weight carried on the head can therefore be calculated using a simple biomechanical model as described by Oatis [50], if the container is assumed to be in static equilibrium. The forces generated during head loading are simplified in this study and assumed to be
the force generated purely by the weight of the water and container carried, directed vertically downward onto the head and spine, with no moment arm."

In the discussion section the following has been added:

‘Frequent loading beyond capacity for adaptation or repair may also lead to early degenerative changes in bone and soft tissues [12]. A threshold of 250N of sustained cyclic loading (15% of failure stress, approximately 6MPa) applied to articular cartilage in vitro has been reported as a threshold above which cell death occurs and increases in proportion to the applied load [59]. Cell death in mature cartilage can lead to degradation of the tissue and is associated with onset of osteoarthritis [59]. Although the actual forces sustained by the cervical spine during water carrying have not been directly quantified, this study indicates that they are likely to exceed 250N for many individuals, when the weight of the head and effects of muscle contraction are added to the weight of water carried. Whilst pain, stiffness and functional impairment are clinical features of osteoarthritis, the correlation between symptoms such as pain and radiographically observed degenerative changes is not clearly established. Therefore future research should investigate the relationships between loading intensity, frequency and duration, history of physical loading exposure and symptoms such as neck or back pain and functional disability, rather than radiographic examination findings alone.’

4 Distance needs to be reported clearly as either the distance/space between household and water source or as a round trip; from the text this is not clear. The distance reported is that from the water source to the home in one direction whilst carrying a filled water container. This is clarified in the text and tables.

5 The RPE could be better described for the reader to understand its application e.g. 0 = no effort, 10 = maximum effort. It is not clear how pain was reported.

The following text has been added to explain RPE and how pain was reported:

‘The modified Borg scale (RPE) [49] was used to gain insight into the intensity of work performed by study participants. The modified Borg scale is a twelve grade category rating scale with ratio properties, which combines verbal and numerical descriptors that can be used to measure a person’s rating of their perceived exertion during a specific task.[49]. A numeric score of 0 equates to a verbal descriptor of ‘nothing at all’, 10 to ‘very, very strong’ and 12 to ‘maximal’. It has been validated for used in diverse populations and used with Xhosa speaking women carrying containers of water in a laboratory setting [43]. In this study participants were presented with a printed Venda version of the scale which was verbally explained to them by the RA. They were asked to estimate the sensation of the effort required for carrying water immediately on completion of a water carrying trip and to point to or choose the verbal descriptor or number most closely matching their sensation of effort.’

‘Participant’s verbal accounts, or ‘self-report’ [48] of their own experiences of water carrying were fully audio-recorded during semi-structured interviews which were conducted in a location chosen by the participants near to or in their own home. The interviews were conducted using open interview guide questions such as ‘Can you tell me about your experiences of carrying water?’ or ‘How do you think carrying water affects you?’ to reduce researcher influences on the type of health impacts discussed by participants. The interview discussions were conducted with immediate verbal translation between Venda and English (on one occasion between Pedi and English) performed by
the RA, to facilitate communication between the RA, principle investigator (JG) and participant. The English questions and the RA’s English translation of the participants’ responses were fully transcribed.’

And in the discussion:
‘Importantly, we may have underestimated the prevalence of pain in the study sample due to our data collection methods. In keeping with a phenomenological approach, open questions about the health effects of water carrying were asked during semi-structured interviews to capture the potentially varied impacts which people who carry water might perceive the task to have. Participants complaining of pain were identified from their responses to the open interview questions and therefore volunteered pain as a health effect without direct prompting or suggestion that it would be linked to water carrying. In most studies investigating pain, structured outcome measures which directly ask about pain intensity or quality are used. Such direct questions may encourage pain reporting which might not be recalled or mentioned in response to more open interview questions.’

6 Calculation of Newtons for head loading could be more fully explained and illustrated.
See point 3

7 One aspect not fully explored is the possible accumulative pressure on body structure leading to reported spinal/neck pain; the association should be with age of respondent, and this could be included.
This has been addressed in the background section:
‘Water filled containers are often carried on the head however transportation with wheel barrows, animal drawn carts or by rolling filled containers has also been observed [7, 8]. These methods obviously create physical demands on the body and the potential for adverse physical stress from regularly carrying loads of water has been recognised [6, 9, 10]. Physical loading of the body within an individual’s capacity for adaptive responses may lead to tissue strengthening, however frequent loading beyond capacity for adaptation or repair may lead to injury through fatigue failure, accumulation of fatigue damage [11] or early degenerative changes in bone and soft tissues [12].

Assumptions have been made that water carrying is detrimental to health and associated with musculoskeletal disorders, such as spinal pain or other joint problems [8, 13, 14]. Such assumptions are supported by strong evidence that the physical demands of work such as handling heavy materials, bending, twisting and lifting, are risk factors for onset of simple low back pain [11, 15] and other musculoskeletal disorders [16, 17]. In particular carrying heavy loads on the head by professional porters has been documented to cause catastrophic injury, such as spinal fracture, dislocation or death [18] and has also been associated with early onset of degenerative changes in the cervical spine [12, 17, 19, 20].

Although head loading due to occupational activities has been associated with degenerative changes in the cervical spine, the relationship between symptoms such as neck pain and activities which require head loading is not clear. Despite a much higher prevalence of upper cervical osteoarthritis in porters (91.6% in male porters compared to 6.8% in the control group) Badve et al [17] stated that an association between symptoms and radiological changes was not found. Similarly, a recent systematic review did not find evidence that cervical disc degeneration is a risk factor for neck pain and reported variable evidence for a relationship between radiographic signs of degeneration and
neck pain prevalence [21]. A recent study found that degenerative changes observed in cervical plain films were poorly related to the severity of symptoms or neck dysfunction in women with chronic pain and working in sedentary occupations [22].

However very few studies have specifically investigated water carrying as it is performed by women and children in developing countries and used appropriate methodologies to investigate its association with health generally or musculoskeletal disorders specifically [10, 23, 24]. Most studies investigating the health impact of physical loading are of male adult workers [17, 25-27] or are situated in more developed countries [28] such that existing evidence may not be applicable to women and children who typically collect and carry water for domestic use [29]. Importantly women and children have reduced injury tolerance for physical loading through the cervical spine compared to men [30-36] and in rural areas may be particularly vulnerable to physical injury due to high levels of poverty, poor health and chronic disease [37-42]. Therefore it is not clear whether regularly carrying containers of water for domestic use leads to detrimental effects such as accelerated degenerative changes in the spine and other joints and whether or not any such effects are symptomatic and impact on health related quality of life.

Two recent reports indicate that some people may experience high rates of perceived exertion and pain sufficient to limit their capacity to carry water containers [7, 43]. Reduced capacity of women or children to collect water due to pain or fatigue may have serious implications for the health of their families. However water carrying is a physical activity which might also lead to beneficial health effects in some individuals. In researching the health impacts of water carrying, it is important to consider health impacts broadly [7] and recognise the limitations of applying existing evidence to this special activity and population group. Researcher assumptions about risk factors and health effects may introduce bias into research methodology in terms of determining the questions asked and outcomes measured and consequently how study participant report the health impacts of water carrying. For example the use of leading questions or outcome measures which assume an association with symptoms such as pain might influence participant responses and their description of the health effects of water carrying.’

And in the discussion:
‘Frequent loading beyond capacity for adaptation or repair may also lead to early degenerative changes in bone and soft tissues [12]. A threshold of 250N of sustained cyclic loading (15% of failure stress, approximately 6MPa) applied to articular cartilage in vitro has been reported as a threshold above which cell death occurs and increases in proportion to the applied load [59]. Cell death in mature cartilage can lead to degradation of the tissue and is associated with onset of osteoarthritis [59]. Although the actual forces sustained by the cervical spine during water carrying have not been directly quantified, this study indicates that they are likely to exceed 250N for many individuals, when the weight of the head and effects of muscle contraction are added to the weight of water carried. Whilst pain, stiffness and functional impairment are clinical features of osteoarthritis, the correlation between symptoms such as pain and radio-graphically observed degenerative changes is not clearly established. Therefore future research should investigate the relationships between loading intensity, frequency and duration, history of physical loading exposure and symptoms such as neck or back pain and functional disability, rather than radiographic examination findings alone.’

8 Although this is a pilot study and largely exploratory, some of the conclusions
should be more fully backed with supportive tables and data. Although the analysis may be (as suggested) complex and the dataset small the relationship between CW/BW%, age, frequency etc could be further explored. These were explored through multivariate analysis as described in the text. We believe that further exploration of the existing data set would constitute ‘data dredging’ and may result in spurious significant findings.

9 The lower volume of consumption of water by those experiencing neck pain could be illustrated.
We did not directly measure water consumption by any study participants and therefore cannot illustrate this.

10 Water carrying is not the only heavy carrying activity conducted by women and girls; there is some evidence that carrying wood can be more arduous than carrying water. This could be an explanatory factor and should be mentioned.
The following is added to the text:
‘Water carrying is not the only manual work performed by women and children in developing countries and future research should also investigate the additional burden from other physical tasks.’

Reviewer: Andrea Rother
We thank this reviewer for the very careful and detailed comments she has provided. It is clear that the issue of water carrying is something she has given a lot of attention to. However, whilst we have responded to many of her suggestions, we consider that we have a very different approach to how empirical research should be presented. In particular we seem to have a very different approach to how empirical evidence is used to draw conclusions. We have resisted the temptation to be too dogmatic in the conclusions we have drawn based on the quantity and quality of the empirical evidence. Much of the additional information and reworking that she requests would not in our opinion add to the conclusions and findings but would add substantially to the length of the paper. We also have concerns that this referee has a different understanding about strength of evidence to ourselves and many people working in the health sciences.

The intention of this paper was not to fully report the findings of the qualitative aspect of this study which used mixed methods (qualitative and quantitative) of data collection. The qualitative findings are reported elsewhere for the children who participated in the study (currently in press) and the adult qualitative data will be reported separately in much greater detail. This is indicated in the paragraph under Methods:

‘This report will focus on the analysis of the quantitative data, combined with some specific findings from content analysis of the qualitative data generated during individual semi-structured interviews. This approach was used to evaluate the relationship between pain, which was a specific health outcome revealed to be of concern to many of the study participants, and potential risk factors observed to occur during water carrying. More extensive and detailed analysis of the qualitative data will be reported separately [7] and will incorporate the findings of additional data generated from ‘natural informal group interviews’ which were conducted according to the methods described by Green and Thorogood [46].’ (pages 111-112 is indicated in the reference list).
As data from natural group interviews or meetings is not presented in this report, the authors do not think it appropriate to go into detailed description of that specific method, which is clearly highlighted and discussed in the referenced text. Additional detail of the methodological principles informing our approach and the methods relevant to the data reported in this paper has been added (see points 15 and 16 below).

Reviewer's report:

Major Compulsory Revisions:

1. Although the question posed is not new (see Dufault 1990; Page 1996), there are no recent and up-to-date research findings on this important issue and this paper does fill an important gap in the literature. However, this paper needs reworking before resubmitting for review.

2. The literature review is weak and should include more articles that touch on water carrying/fetching and health implications (a few listed below) and indicate more clearly how this study will fill the gaps in the literature that exists. That is, what is new about this research? There are other health benefits of increased access within the range implying Physical collection, notably reduced potential for damage to the spine and for the early onset arthritic diseases and protection against hip damage (Dufault, 1988; Page, 1996)


Gendered implication of access to clean water for the girl child: A case study in two rural villages in Ethiopia


Sultana, Farhana(2009) 'Fluid lives: subjectivities, gender and water in rural Bangladesh', Gender, Place & Culture, 16: 4, 427 — 444

To link to this Article: DOI: 10.1080/09663690903003942 – briefly mentions health implications from water carrying

Reference to potentially relevant research and that which touches on the health impacts of water carrying has been added in the background information and discussion. We have also highlight that most discussions in the literature about water carrying, including the references detailed by the reviewer, do not cite any empirical data on the physical health effects of water carrying and either rely on anecdotal information, or make unsubstantiated and speculative claims about causal relationships between water carrying and specific health condition and symptomatic complaints.

5. The authors are strongly encouraged to have this paper edited for English grammar and sentence construction. A few examples:
   o Pg 4. Line 12: add “are” between ‘interventions’ and ‘not prioritized…’
   o Suggest removing many of the “may” in the text to make the paper stronger (e.g., pg 4, second to last line in first paragraph: “…which may have [instead state…which has] important health consequences for those who perform the task...).
The issue is to fairly represent the conclusions that can be drawn from the evidence and not to strengthen the force of argument irrespective of the quality and strength of evidence. Therefore we do not intend to make any changes.

6. The methods section needs a fair amount of work to strengthen it. A lot more detail needs to be provided (suggestions mentioned below) in order for others to be able to evaluate the quality of the study, as well as to be able to reproduce it. In this paper there appears to be a bit of confusion between methods and methodology. Methods refer to specific techniques, whereas methodology refers to underlying principles of inquiry. Thus the statement “a phenomenological methodology was used” is referring to methods (i.e., approaches used) and not methodology (i.e., the theories and principles of phenomenology). This needs to be corrected. This may help to strengthen the presentation of the qualitative data which is currently weak.

Additional detail has been added and is highlighted in the text as described below

Methods:
15. This section needs to be rewritten and re-organized. I found several of the questions I had in the beginning of the section were actually addressed much later in the section.

Additional detail has been added and is highlighted in the text and the section has been re-organized

16. Explain phenomenological methodology and which approaches within this methodology the study used. Reference the main phenomenological principles, approaches and theorists used in this research. Remember that one should not try to convince the readers of the validity of one’s observations based on the power of a fieldwork approach; rather provision of sufficient details about how the data was obtained is key.

We have added information under ‘methods’ on the methodological approaches which informed this research with reference to a key text explaining phenomenology and a key paper explaining ergonomic principles. We have also added more detailed explanation of data collection methods. The following has been added to the text:

‘A mixed methods approach was taken, utilising both quantitative and qualitative data to better understand domestic water carrying as it is performed and experienced by adults and children in Limpopo Province. Ergonomic principles were used to develop the approach to quantitative data collection. An ‘ergonomic’ evaluation of work incorporates assessment of a broad range of potential risk factors related to the environment, organisation of work, the nature of the task or the individual [44].

Qualitative enquiry in this study was influenced by the principles of phenomenology as described by Creswell [45] and used to explore the lived experience of water carrying. Individuals with direct experience of water carrying will have unique understanding of the task and can provide insight into how it might impact upon their own health and
functioning. As the health effects of water carrying are unknown and might be experienced and interpreted variably by different individuals, such insights can indicate the domains of health which are relevant to people who perform water carrying and therefore important to evaluate for a potential association with the activity.

17. When was the study conducted? Mention the months and years.
The following information is added to the text:
'The six villages in the study area were visited on two occasions; over a 3 week period in March 2008 and a two week period in October 2008. The first period was for initial qualitative and quantitative data collection. The second period was to feedback preliminary study findings to participating communities, create an opportunity for community members to comment on the initial interpretation of qualitative data and explore levels of support for future research into water carrying.'

18. Pg 5 line 7 under methods: explain “natural group meetings”.
As the intention of this paper was not to fully report the findings of the qualitative aspect of this study and in particular the findings from group interviews will be reported elsewhere, the following is added in the text to explain this:
'More extensive and detailed analysis of the qualitative data will be reported separately [7] and will incorporate the findings of additional data generated from ‘natural informal group interviews’ which were conducted according to the methods described by Green and Thorogood [46].’ (pages 111-112 is indicated in the reference list).

Sampling Strategy, etc:
19. Briefly describe each village and the water service situations and environment in each to highlight why they were chosen.
Village population and water service situations have been added to table 2. Explanation of why the villages were chosen is included in the text:
'The villages were purposively selected to include a range of water service situations and environments which might have different physical effects or expose people to different risk factors for injury or disease. Villages and the water source points within them were chosen to include variations in terrain which might influence methods and effects of water carrying in different ways. For example many people in one village relied on water sourced from a mountain spring, accessible via steep, slippery and rocky footpaths. Another village, located on a flat plain relied mainly on communal taps accessed via sandy pathways or roads.'

20. Why was Limpopo province chosen over other provinces? Give a bit of information about Limpopo province that is relevant for this research.
The following has been added in the text: 'Data was collected from 6 villages in Limpopo Province, South Africa. Limpopo was chosen as the study area because it is a district with high levels of poverty and where suboptimal water supply is likely to have considerable health impact [47]. It is also a region which is broadly comparable with other poor rural districts of South Africa and other developing countries. The predominant cultural group in the area are the Venda people.'

21. What was the distance between each village study and where were they located within the province? A map would be beneficial.
We do not feel that the distance between each village is relevant to the aims or findings of the study. To ensure confidentiality of the people and comments made in the study, we feel it is better to not provide a map or name the villages included.
22. Who sought permission from each headman?
The following has been added to the text:
‘Before commencing research, permission for the researchers to work in each village was sought from the ‘headman’ of each village by the research assistant (RA), a 29 year old Venda male, fluent in several languages including Venda and English and intimately familiar with local customs.’

23. Explain why each village was visited over a period of two or three consecutive days. What was the purpose? Observations only? Were there discussions? With whom? Etc.
The following has been added to the text:
‘Each village was then visited over a period of two to three consecutive days by the principle investigator (JG) and the RA, during which qualitative interview data and quantitative observational data was gathered. Work was ceased in each village when qualitative and quantitative data had been collected from a sample with representation of people with a range of ages, of each gender and with variation in the terrain, type of path and distance over which they walked to collect water.’

24. Did every headman approach grant permission or did some refuse? Why?
The following has been added to the text:
Six headmen were approached, informed of the study purpose and procedures and all gave permission for access to their village. ’All headmen gave verbal permission for the researchers to access their village.’

25. Pg 6, line 1: “Specific water source points were chosen…” where? In each village or one type per village? How many different types were selected?
The following text has been added: ‘In each village specific water source points were chosen according to what was available in the village and to include representation in the study of varying water sources (a river, natural springs and communal taps) and infrastructure (for example water pumping station over-flow pipes or communal taps with differing construction design).’

26. Pg 6, line 5: “….were approached…” Here is where they questions approached by whom and in what language should be answered.
The following has been modified as indicated in the text: ‘People observed to be intending to collect water were initially approached by the RA and briefly informed in their preferred language of the study purpose and procedures. Those willing to participate were provided with more detailed explanation of the study both verbally and with participant information sheets written in TshiVenda.’

27. What was the literacy level of the study participants? How many could read the writing consent sheets provided to them?
The following is added to the text: ‘It was assumed that all participants may have had poor literacy skills as it was not possible to accurately evaluate the literacy level of each participant in the field. Therefore the study purpose and procedures and voluntary participation with entitlement to withdraw from the study without consequence were explained to all participants in their preferred language. All were also provided with information and consent forms written in their preferred language in both a detailed written form and an ‘easy to read’ version which included graphic illustrations rather than any sections of lengthy text. Both versions of the information and consent forms were translated from English into Venda by the RA and then independently back translated by
a local native speaker of Venda. The back translation indicated that conceptually accurate and meaningful translation of the documents was achieved.'

28. How was consent granted? Signed? Verbal?
Signed by adults, for children signed by adults on their behalf with verbal agreement from the child which is indicated in the text explaining how consent was obtained.

29. How many people were approached in each village?
Only three people who were approached in village 2 declined to participate in the study. This was already explained in the text: ‘Of those invited to participate in the study only three declined. Forty three people were recruited to the study for collection of observational data and/or semi-structured interviews. Four participated in semi-structured interviews but were not observed carrying water, leaving a total sample of thirty nine people from whom observational data was collected (Table 1)’ The number of people approached is the same as the number of participants included in the study which is indicated in table 2.

30. How many children and how many adults were observed?
This information has been added to table 1

31. Pg 6, lines 13-14: “Care was taken to monitor from children’s behaviour....”
Who did the monitoring? Give an example of what was seen to be an adverse behaviour as a result of this study. ‘Care was taken by the PI and RA to monitor from children’s behaviour that they were not adversely affected by participating in the study,’ and ‘No behaviour to indicate that any adverse effects occurred as a result of participation in the study was observed.’ has been added to the text.

32. How many children were observed collecting water without an adult?
Added to table 1

33. How did the researchers ensure that the parent or guardian approached for consent that their child was videoed, weighed, etc. was really their child and not just the child making it up?
The right to provide consent for the child’s participation was established through verbal discussion in Venda between the RA (a local Venda male), the child and the adult providing consent. In the text the following has been added: ‘On arrival at the house, a parent or adult guardian was identified through discussion conducted in TshiVenda between the RA, child and adults present. The adult identified in this way as guardian for the child was advised of the study purpose and procedures, and formal written consent for the child’s participation sought.’

34. Pg 7, line 3: of the 43 recruited, how many were children, adults, male and female?
‘Four participated in semi-structured interviews (one female child, two women and one man) but were not observed carrying water, leaving a total sample of thirty nine people from whom observational data was collected (Table 1)’ is added to the text and Table 1 indicates numbers of male and females, adults and children whose data is discussed in this report (N 39)
35. How were the 29 people from the total 39 selected for the interviews? ‘purposively chosen to meet the inclusion criteria and ensure representation of males and females with a range of ages.’ is included in the text

*Where were the interviews conducted, by whom and in what language? ‘Participant’s verbal accounts, or ‘self-report’ [48] of their own experiences of water carrying were fully audio-recorded during semi-structured interviews which were conducted in a location chosen by the participants near to or in their own home. The interviews were conducted using open interview guide questions such as ‘Can you tell me about your experiences of carrying water?’ or ‘How do you think carrying water affects you?’ to reduce researcher influences on the type of health impacts discussed by participants. The interview discussions were conducted with immediate verbal translation between Venda and English (on one occasion between Pedi and English) performed by the RA, to facilitate communication between the RA, principle investigator (JG) and participant. The English questions and the RA’s English translation of the participants’ responses were fully transcribed.’ is added to the text

*How many from each village? Was each village adequately represented?* This is explained in the following text and table 2 has been added for clarification

‘Of those invited to participate in the study only three declined. Forty three people were recruited to the study for collection of observational data and/or semi-structured interviews. Four participated in semi-structured interviews but were not observed carrying water, leaving a total sample of thirty nine people from whom observational data was collected (Table 1). Twenty nine of the people observed carrying water were also participants in semi-structured interviews, purposively chosen to meet the inclusion criteria and ensure representation of males and females with a range of ages from each village (Table 2). Additional study participants were recruited to individual or group interviews but were not observed carrying water and are therefore not included here. Findings incorporating their data will be reported elsewhere. Villages 5 and 6 were two small villages in close proximity to each other and with similar environments; therefore participants from these two villages were grouped together.’

**Table 2 - Participant numbers per village and data collection methods**

<table>
<thead>
<tr>
<th>Village (population)</th>
<th>Water system</th>
<th>Alternative water sources</th>
<th>Observed carrying water</th>
<th>Observed carrying water &amp; SSI¹</th>
<th>Observed carrying water &amp; NGM²</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 (est 1000)</td>
<td>Communal taps (number unknown)</td>
<td>Unknown</td>
<td>9</td>
<td>8</td>
<td>1</td>
</tr>
<tr>
<td>2 (2,457)</td>
<td>43 communal taps</td>
<td>Stream or borehole</td>
<td>5</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>3 (5,286)</td>
<td>45 communal taps</td>
<td>River, canal, borehole or pumping station over-flow pipe</td>
<td>13</td>
<td>8</td>
<td>3</td>
</tr>
<tr>
<td>4 (1,129)</td>
<td>2 springs</td>
<td>Plastic water tank filled by water tankers</td>
<td>8</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td>5 &amp; 6 (719)</td>
<td>23 communal taps</td>
<td>River, spring or</td>
<td>4</td>
<td>1</td>
<td>3</td>
</tr>
</tbody>
</table>
36. Inclusion criteria: how was residency of participants determined?
This was determined through discussion between the RA and the participant to confirm that they reside in the village more of the time than anywhere else, however we do not believe that this information would add to the key messages of the paper.

37. Exclusion criteria: how did you control for existing musculoskeletal conditions that were not related to water carrying? How did you handle pain related to other conditions?
It is not possible to do this without clinical assessment or a detailed medical history from each participant, which was beyond the scope and intention of this study. We do not claim to make a diagnosis of the source of reported pain, but rather discuss common potential causes of regional pain and present background information which suggests that the musculoskeletal system is a likely source of pain; we discuss the complaints of regional pain reported in semi-structured interview as ‘symptoms typical of musculoskeletal disorders such as neck or back pain’. However, we also discuss some other possible co-morbidities which may affect the population studied.

Data Collection
38. Give examples of questions asked in the interviews.
This is done to explain how data on pain was collected, with the following text: ‘The interviews were conducted using open interview guide questions such as ‘Can you tell me about your experiences of carrying water?’ or ‘How do you think carrying water affects you?’ to reduce researcher influences on the type of health impacts discussed by participants.’

39. Pg 8, line 3: give examples of “simple measurements”.
These are given in the subsequent sentences

40. Pg 8, line 5: briefly describe in a few sentences the methods used from Green and Thorogood as surely there are many discussed by them and the reader should not be expected to go to the book to figure out which methods were used.
Detail is added and relevant sections of the text indicated in the reference list

41. Pg 8, line 5: what “procedures” were piloted? Were these piloted with the study participants? In which village?
Details is added in the text: ‘Qualitative and quantitative data collection procedures were piloted in the study area with a Venda speaking woman during and after a water carrying trip, to ensure that interview questions were easily understood and facilitated relevant discussion and that measurement methods to collect quantitative data were feasible for use in the field.’

42. Pg 8, line 6: give an example of how feasibility was improved.
See point 41.

43. What instrument was used to measure the water and the person?
‘bathroom scales’ has been added.
44. What was the reason for calculating weights from the mean value of three consecutive weighing scores? Explain. ‘To reduce measurement error’ is added to the text.

45. Give examples of how pain related questions were asked.
   This has been provided, see response to Dave Hemson comment 5.

Data Analysis:
46. Pg 9 – explain a bit more as to why and how the Borg scale was used to measure participants’ perception of the effort require for carrying water.
   Has been added see response to Dave Hemson comment 5

47. Pg 9, second paragraph: how was this data categorized/analysed within each subtask? Were these four subtasks for analysing body postures? What else?
   We do not believe this would add significantly to the key messages of the paper but can be provided to readers on request from the corresponding author.

48. Pg 9: “The video material was analysed……so that specific criteria…” What were these criteria?
   We do not believe this would add significantly to the key messages of the paper, but can be provided to readers on request from the corresponding author.

49. Pg 9, paragraph 3: Table 1 presents the demographic data for all 39 participants, however, what are the age, gender, etc of the 29 interviewed?
   We do not believe this would add significantly to the key messages of this paper and greater detail of the qualitative data will be reported elsewhere.

50. Did you record how long participants had been carrying water for the duration of their life? At what age they started and how old they currently were? Surely this would have an influence on pain, posture and health effects.
   We intend to collect such data in future research, but this was beyond the scope of this exploratory study.

51. Pg 10, lines 2-3: “There were insufficient numbers…..using other methods of carrying water”. Such as? Give examples of other methods.
   These are described previously, under methods of water carrying ‘Three methods of carrying water were observed. These were 1) head loading of water-filled containers (n = 30), 2) rolling a water-filled drum (n =2) and 3) pushing a wheelbarrow weighted with filled water containers (n = 7).’

63. Include a paragraph on study limitations. Include large variation in N in, for example, Table 3.
   The large variation in N results from the sub-grouping and is due to the small study sample size; this is highlighted as a limitation in the final paragraph.

Minor Essential Revisions:
Abstract:
8. In the results section add “(N= ?)” after women and after children
   We do not believe this would add to the key messages of the abstract, but would add to the length and limit the other information included. Detail is provided in the text.
9. In the results section, line 3, how did you differentiate between the back pain that was part of the 69% spinal pain and the 38% back pain?

This is defined in the text: ‘The prevalence of spinal pain, defined in this study as pain reported or indicated through gesture by participants to be in the head, neck, thoracic or lumbo-sacral region during qualitative interview, was 69% and of back pain only (pain indicated to be in the lower back or thoracic region) was 38% (Table 5).’ It would add significantly to the length of the abstract to be included here.

10. There are efforts to reduce head carrying (e.g., rolling water containers). Perhaps the preliminary findings of this study should be used to support such efforts, and therefore mentioned in the conclusion.

We do not consider that the results of such a preliminary study can be used to draw such specific conclusions

Background:

11. Pg 4, lines 9-11: This paper does not address “all health impacts....” such as effects on hips

No it does not. We do not claim to address all health impacts with this study, but highlight that broader understanding of health impacts is important; we have modified the relevant sentence as follows: ‘Understanding the health impacts of sub-optimal water access more broadly is crucial for appropriate and sustainable water resource development.’

12. Need to include a paragraph discussing studies on musculoskeletal damage and pain.

This is now included in the background and discussion

13. The third research question on page 4 is not clear. What is meant by “in other settings”?

Detail is now added to the question: ‘in more developed countries and occupational settings,’

14. Pg 5, last research question: “How does musculoskeletal pain impact on the ability to carry water?” This question was not answered by the research findings. Instead how pain effected the individual was discussed.

We have removed ‘musculoskeletal’ from the research question

Results:

52. Why is the quote on page 10 not in bold, but subsequent quotes are bolded?

53. Pg 10, last line: why does N=30? Should in not be 29?

N=30 is correct, this describes the number of people who were observed whilst they carried water using different methods. 29 is the number of people who were observed and participated in semi-structured interviews. Some people who were observed participated in group interviews.

54. Generally statistics cited in the text are rounded up (e.g., 20% not 20.2%) and statistics cited in brackets include one numeral after the decimal point.

This has been changed in the text.

55. In the abstract it was stated that the aim of the study was to 1) understand
how domestic water carrying is performed, 2) identify potential health risk factors, and 3) gain insight into possible health effects of the task. One is covered in the results, but what is not clear is which headings currently listed in the results section answer questions 2 and 3. I suggest that this be clarified by adding a heading (e.g., Health Risk Factors) and then put the relevant headings as sub-headings (e.g., weight of water carried) – this can be done either in the results section or the discussion section, or both.

Additional headings have been added in the results section

56. Pg 11, lines 2-3 under Weight of water carried: “...women typically carried one container.” Per day? Per time?
‘Per trip’ has been added to the text

57. Pg 12, last 3 lines: this should be in the methods section – “Polynomial regression analysis....”
This has been removed from the paper

58. The qualitative data needs to be presented better. I suggest the authors read up on how to present qualitative data. As this section is weak and the authors no doubt have a lot of data, I suggest this is rewritten and more data is included.
We do not intend to present the qualitative data in full in this report. We do not believe that additional data would add to the key messages or validity of the paper, but would add significantly to its length.

Discussion:
59. Several sections of the discussion should be in the background section and this would strengthen the literature review. For example:
o Pg 15, lines 6-10: “It may be relevant that women in....”
o Pg 16 lines 1-9 and lines 11-13.
We do not agree that the sections should be moved, however, the background section has additional detail added

60. Pg 14, last line: was the prevalence of lower back pain to do with occupational exposures or what?
Prevalence is a descriptive statistic. We have highlighted the associations found in this study between reported spinal pain and distance walked and between RPE and container weight and incline.

61. Last 4 lines on pg 15 should be put in the conclusion: “Future research should....”
We do not agree, this is not a major conclusion. Our recommendations for future research are included in the conclusion.

62. Pg 16, second paragraph, lines 1-5: rewrite (sentence too long) and explain why. “Compression forces....”
This has been addressed with information on injury tolerances in the background section and greater explanation of how force generated by the weight of water carried were calculated in this study

65. Why are none of the findings discussed in relation to the phenomenological methodology used in this study?
This is done in relation to the prevalence of pain, which is the main way in which the use of qualitative data was reported here. The following is added in the text:

'Importantly, we may have underestimated the prevalence of pain in the study sample due to our data collection methods. In keeping with a phenomenological approach, open questions about the health effects of water carrying were asked during semi-structured interviews to capture the potentially varied impacts which people who carry water might perceive the task to have. Participants complaining of pain were identified from their responses to the open interview questions and therefore volunteered pain as a health effect without direct prompting or suggestion that it would be linked to water carrying. In most studies investigating pain, structured outcome measures which directly ask about the participant’s pain are used. Such direct questions may encourage pain reporting which might not be recalled or mentioned in response to more open interview questions.'

However the intention of this report was not to focus on the qualitative aspect of the study in detail. The qualitative findings will be reported in much greater depth elsewhere.

Discretionary Revisions:
3. As this is a pilot study, it would help if the authors included their conceptual model for this research. See Buor 2004 article and conceptual model. This would also help with the flow of the article which at times jumps around.

Health & Place Volume 10, Issue 1, March 2004, Pages 85-103
Water needs and women's health in the Kumasi metropolitan area, Ghana
Daniel Buor
We do not consider that we have sufficient empirical data in order to yet develop or validate any conceptual model

4. The title would be strengthened by adding the word “musculoskeletal” between ‘for’ and ‘health’.

We do not claim to have investigated musculoskeletal health and have removed the word ‘musculoskeletal from the last research question to be consistent with this, rather we investigated health effects which were reported by participants during semi-structured interviews, which included pain described by its regional location. Pain is a symptom typical of musculoskeletal disorders and although we present information which suggests disorder of the musculoskeletal system as a likely or possible cause of symptoms, we did not diagnose specific conditions in this study. We also discuss co-morbidity which may account for the symptoms reported in semi-structured interviews.

7. The phenomenological methodology used should be discussed in relation to the findings in the discussion section.

This is done in relation to the prevalence of pain. The following is added in the text:

'Importantly, we may have underestimated the prevalence of pain in the study sample due to our data collection methods. In keeping with a phenomenological approach, open questions about the health effects of water carrying were asked during semi-structured interviews to capture the potentially varied impacts which people who carry water might perceive the task to have. Participants complaining of pain were identified from their responses to the open interview questions and therefore volunteered pain as a health effect without direct prompting or suggestion that it would be linked to water carrying. In most studies investigating pain, structured outcome measures which directly ask about the participant’s pain are used. Such direct questions may encourage pain reporting which might not be recalled or mentioned in response to more open interview questions.'

64. Sub-section titles in this section (as mentioned above) would help to reinforce
the findings and to discuss these in relation to the aims of the study. We have added subheadings in the results section

66. Give a few brief examples of interventions that could reduce risk factors of musculoskeletal disorders identified in this study. It is premature to do this

67. The conclusion would be strengthened by linking the study findings to borderer national and international initiatives to address water issues including water carrying (e.g., MDG’s). At present this is beyond the remit of this paper

Level of interest: An article whose findings are important to those with closely related research interests
Quality of written English: Needs some language corrections before being published
Statistical review: No, the manuscript does not need to be seen by a statistician.
Declaration of competing interests:
I declare that I have no competing interests.