Risk factors for strap-related lesions in working donkeys at the World Heritage site of Petra in Jordan

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Abstract

A risk analysis was undertaken in an attempt improve improvised rump straps on donkeys carrying tourists at the World Heritage Site at Petra, Jordan. Tail-base lesions were identified in 63 of the 86 donkeys. Observations and questionnaires were used to collect data relating to the straps, donkey health and human attitudes. Worse lesions were associated with padded than unpadded straps, if tightly fitted. Padding could be a cause of, or a response to, lesions, but results suggest that it did not effectively aid healing. Significantly worse lesions occurred with unclean than clean straps and, contrary to many recommendations, cotton straps were associated with worse lesions than were synthetic straps. Since this was an exploratory study, findings should be considered to generate (not to test) hypotheses and any resulting interventions will require monitoring. Further possible risks are discussed, referring to medical and veterinary literature and applied expertise in working equines.

Keywords: Animal Welfare; Equine; Donkey; Dermatology; Working animals; Epidemiology
Introduction

An estimated 39 million donkeys live in the developing world (FAO, 2005) and the majority are used to transport people and goods, often across difficult terrain where vehicles are unsuitable or unaffordable. At the ancient Nabataean city of Petra in Jordan, donkeys are used to carry tourists up the 900 steps to a tomb called the ‘Monastery’. In a preliminary survey commissioned by an equine charity, the Brooke, and carried out in 2002, 59% of the donkeys had lesions at the base of their tails, with 14% having severe lesions that broke the skin and immediate subcutaneous layer (Whay et al., 2006). This is a much higher prevalence of severe tail-base lesions than the 1.6% generally seen in ridden donkeys in developing countries (Pritchard et al., 2005). Despite donkeys at Petra also having other health and welfare problems, these lesions were selected as the first issue for intervention because of their prevalence, severity, anticipated duration and because previous attempts to tackle this problem had limited success (Whay et al., 2006).

The position of the lesions, underneath the tail (between the tail-base and the perineum), strongly suggests that they are caused directly or indirectly by some aspect of the rump straps used to prevent the saddle from slipping forwards (see Fig. 1). The rump straps are made from locally available, inexpensive materials including synthetic or cotton webbing, rope, blankets, cotton sheets, fleece or wool. The Brooke had previously attempted to prevent these lesions from developing by recommending and providing wide cotton webbing straps, in an effort to dissipate pressure across a wide area, to wick away sweat and to provide a relatively smooth surface, similar to suggestions made by previous authors (Dibbitts, 1997; Pearson et al., 1999; Starkey, 1997). However, this intervention had limited success. Therefore, the current study was commissioned as an initial risk analysis, aiming to generate hypotheses about what factors, directly or indirectly related to the strap, might contribute to the development of the tail-base lesions (Greenland et al., 2004).

The donkeys at Petra are each attended by a local Bedouin, who is not necessarily the donkey’s owner. Since the work is poorly paid, these predominantly male attendants have usually
received little education and are often children, teenagers, or adults with learning difficulties. They receive little training or information regarding donkey husbandry and health, as is the case with most donkey owners worldwide, partly because donkeys are regarded as relatively low-status animals (Pearson et al., 1999; Starkey, 1997). Any intervention would rely on solutions that could be readily and sustainably applied by these attendants (Krecek and Waller, 2006), so human factors were taken into account in our approach. Also, to assess whether there were concrete incentives to encourage attendants to make any necessary change, information was also collected about whether the lesions reduced the work-output of the donkeys, as is often suggested (Pearson et al., 1999; Starkey, 1997).

Apart from the qualities of the strap that could lead to lesion formation, other more indirect factors were also assessed. Candidate risk factors were identified, not only through our own previous studies of working equines (Pritchard et al., 2005, 2006), but also with the aid of three main bodies of literature: medical literature concerning textiles and human skin, veterinary reports on equine dermatology and literature generated by experts on working animals or animal harness design. Factors describing body condition and health, from descriptors of the donkey itself to husbandry parameters, were assessed because these could determine how susceptible donkeys would be to developing lesions and subsequent infections (Pascoe and Knottenbelt, 1999; Pritchard et al., 2005, 2006).

In addition, aspects of the human-animal bond were assessed since, in farm animals, for example, health and productivity can be reduced by fear of their human caretakers (Rushen et al., 1999; Hemsworth, 2003). Perceived methods of treatment and prevention of lesions were evaluated, in case they could inform intervention approaches. Availability and perception of veterinary care (which is provided by the Brooke) was also assessed in relation to the prevalence and severity of the lesions for feedback purposes.
Our aim was to identify risk factors that might be associated with tail-base lesions, with a view to developing targeted intervention strategies and hypotheses for future studies. We also aimed to gain a fuller understanding of the motivations and requirements of the humans that influence the donkeys’ welfare, i.e., the attendants and the tourists, so that interventions could be more successfully implemented.

**Materials and methods**

**Animals and data collection**

Data were collected on all the donkeys working at the time of the study (n = 86). Donkeys were observed during their working day over a 4 week period (October-November 2004). A condensed list of the data collected is shown in Table 1. The questionnaire can be seen online as supplementary material and further details are described by Pritchard and Whay (2004). The lesions were described in terms of their surface area, depth, location around the tail and whether they were inflamed or had any discharge. This information was later used to create a composite score (Table 2).

Data were collected about the fit of the harness and saddle, rider behaviour and the gait of the donkey, through observing each donkey either carrying a tourist up the steps (n = 65), or carrying a tourist or its attendant down the steps (n = 28); eight donkeys were observed during both journeys. The observers aimed to ensure that the donkey attendants were unaware that their behaviour and their donkey were being observed during each of these journeys. Data from journeys up or down the steps were analysed separately, to prevent heterogeneous categorisation of harness fit, rider behaviour and donkey gaits.

After each journey, the tourist was interviewed about what influenced their decision to choose that donkey. The donkey was assessed for lesions, general health, its attitude towards humans and factors to describe its rump strap. A small section of the donkey’s mane was cut to help avoid
sampling the same donkey again. Finally, the attendant was interviewed about when they acquired
the donkey and details of their working schedule, their husbandry routine and their methods for
preventing and treating tail-base lesions.

Statistical analyses

Statistical analyses were carried out using SPSS and Minitab, both versions 14. For most
analyses, the dependent variable was a score of lesion severity ranging from 0-6 (Table 2). Non-
parametric analyses were used, including Kruskall-Wallis for testing the effects of variables with
more than two levels and Mann-Whitney tests for post-hoc analyses of where any significant
differences lay in the aforementioned variables, or for testing two-level variables. We used $\chi^2$ tests
for categorical data, such as effects on the presence or absence of lesions. Spearman rank correlations
were used to test relationships between ordinal scores. For normally distributed dependent variables,
such as the numbers of hours worked by the donkeys per week, general linear models were used and
model assumptions were checked by graphical inspection (Grafen and Hails, 2002).

Because this was an exploratory study investigating a system about which very little is
known, multiple variables of interest were tested (Bender and Lange, 2001). We used $P$ values to aid
decision making (Gigerenzer, 2004), using the traditional significance level of $\alpha = 0.05$, because a
more conservative significance level would have increased the risk of Type II errors (i.e. missing
potentially important but weak contributing factors) (Bender and Lange, 2001). We did not include a
post-hoc power test, since power will differ for each specific variable tested and post-hoc tests
contribute no more information than the $P$ values themselves (Hoenig and Heisey, 2001; Colegrave
and Ruxton, 2003). Therefore, it should be remembered that a lack of significance may be due to a
lack of power rather than a true lack of effect and results of this exploratory study will require
confirmation through future work (Greenland et al., 2004).
Results

Risk factors for lesions

The prevalence of lesions increased from 59% in the preliminary 2002 survey to 73% in the current study, with 33% of donkeys at the time of the study having lesions that broke the skin and immediate subcutaneous layers. Results are summarised in Table 3.

Padding was associated with worse lesions if the straps were also tightly fitted (Fig. 2); thickly or partially padded straps were associated with more severe lesions than were unpadded \( (P = 0.010) \) or thinly padded straps \( (P = 0.023) \). ‘Tight’ straps were those where the observer’s hand could not be comfortably inserted between the strap and the rump and ‘padded’ straps were those that comprised soft, non-structural material (with subjective descriptors of the quantity and distribution of padding). Details of the types of padding can be seen in Table 4. Donkeys with dirt (dust, grit, mud or faecal matter) on their straps also had more severe lesions than those with clean straps \( (P = 0.001) \) (Fig. 3). The relative risk of dirt for the presence of uninfected lesions (i.e., excluding donkeys with infected lesions) was 1.3 \( (\chi^2 = 1.31; n = 52; P = 0.259) \), while the relative risk of dirt for lesions becoming infected was 1.6 \( (\chi^2 = 3.98; n = 61; P = 0.046) \) (i.e., excluding donkeys with no lesions).

A Kruskall-Wallis test showed that strap materials affected lesion severity \( (H = 15.04; DF = 4; P = 0.005) \) (Fig. 4; Table 4). The differences were due to synthetic ropes being associated with less severe lesions than cotton sheet \( (P = 0.001) \) and fleece \( (P = 0.006) \) straps and synthetic webbing being associated with less severe lesions than cotton sheets \( (P = 0.023) \). Taken overall, synthetic straps of all types were associated with less severe lesions than cotton straps of all types \( (P = 0.002) \). We found no relationship between straps’ material and their padding or cleanliness.

Donkeys whose attendants stated that they changed the strap at fixed intervals had more severe lesions than those whose attendants stated that they changed the strap whenever it broke \( (P = \)
or caused injury \((P = 0.039)\); there was no significant effect in those saying they changed it whenever it became dirty \((n = 12; P = 0.119)\). There was a trend towards more severe lesions when attendants were observed hitting the donkeys with their hands on journeys up and down the steps, compared with those not observed hitting the donkeys \((P = 0.052)\). This trend was not seen in attendants hitting donkeys with sticks. No other husbandry variables, or donkeys’ general characteristics or behaviour showed a relationship with the severity or existence of lesions.

**Human factors**

Of the 86 attendants interviewed, 50 stated that their donkey having a lesion would be a circumstance that would prevent them from using the donkey (i.e., they would rest it), but this showed no relationship with the likelihood of their donkeys having tail-base lesions, nor with their work outputs; in fact, of the four donkeys working with the most severe lesions, three of their attendants had stated that the donkey would be rested if it had a sore. When the attendants were asked what measures, if any, could prevent tail-base lesions from forming, the most common suggestion was to use a smooth strap \((n = 38)\), followed by using a smooth and padded strap \((n = 23)\); only one attendant suggested cleaning the strap regularly (Table 5). The most frequent suggestion for treating lesions was to take the donkey to the Brooke’s veterinary clinic \((n = 58)\) and applying padding to the strap was suggested by five attendants (Table 5).

Veterinary care is provided (by the Brooke) during working hours in the village of Bedoul, half an hour’s walk away from Petra, and most attendants stated that the timing \((72/84)\) and location \((68/85)\) of this veterinary service was adequate. The vast majority of attendants stated that they considered it to be mainly their own responsibility, rather than the Brooke’s, to prevent \((72/83)\) and care \((75/84)\) for their donkeys’ lesions. Measures of access to veterinary care or advice showed no relationship with lesion severity.
Most (58/85) attendants stated that lesions ‘often or almost always’ recovered after veterinary care, but attendants’ perception of healing success related to the severity of their donkeys’ lesions; those who stated that sores never healed or recurred regularly had donkeys with more severe lesions, compared with those who reported that lesions healed and did not recur ($P = 0.007$). When attendants were asked what form(s) of veterinary information about preventing or treating lesions they would like to be provided with, if any, 52 of the 85 requested pictures or audio-video material and 57 requested interactive group training (e.g., at school or as a club), compared with only two people who requested written information. Also, more attendants stated that they required advice ($n = 33$) or tools or equipment ($n = 36$) than practical help ($n = 19$).

There was no apparent relationship in either direction between the donkeys’ lesion severity and their work output (journeys or hours per week), or the likelihood of them being chosen by a tourist. Of the 69 tourists successfully interviewed, reasons given for choosing particular donkeys included that it was the first available or that the attendant approached the tourist ($n = 26$), that the donkey looked strong and healthy ($n = 19$), that they liked some aspect of the attendant’s manner or appearance ($n = 9$), that someone else chose for them ($n = 9$) or that the donkey was aesthetically pleasing in some way ($n = 8$). Donkeys that were chosen because they looked strong and healthy had higher body condition scores (i.e., were less thin) than those chosen because they were the first available ($P = 0.048$). Most of the tourists were from Western ($n = 57$ out of 83) or Eastern Europe ($n = 16$) and we observed no patterns relating to nationality.

**Discussion**

The aim of this study was to identify some likely causes of tail lesions in donkeys at Petra and to begin to understand the motivations and requirements of the relevant human populations, with a view to designing sustainable interventions. Despite these data being correlational and providing only a cross-section of these donkeys’ situations, several risk factors emerged. Tightly fitted, padded straps were associated with more severe lesions than other strap types.
Padding is often recommended to make straps more comfortable and to reduce sores (Barwell and Ayre, 1982; Dibbitts, 1997; Pearson et al., 1999; Pearson et al., 2003) and use of smooth padded straps was the second most common suggestion made by the attendants for preventing lesions. The correlation could therefore be due to the donkeys’ attendants responding to tail lesions by padding the straps, although only five of the attendants (6%) reported that padding could be used to treat these lesions.

Alternatively, there is some evidence to suggest that the padding could have been a causal factor in lesion formation; in humans, although padding is effective protection against percussive forces where clothing or straps cover bony prominences, it is usually of no benefit to protect soft tissue from trauma caused by slow-onset forces or friction (Meinander and Varheenmaa, 2002), as would be the case with these rump straps. Moreover, badly placed padding with an uneven surface can cause sores or discomfort in humans (Meinander and Varheenmaa, 2002) and in horses with padded plaster casts (Pascoe, 1990); in these donkeys the padding is usually made by wrapping thick materials roughly around a thinner strap, often with pronounced lumps and protrusions (Fig. 1). Whether padding is a cause of, or a response to, more severe lesions, the positive correlation between padding and lesion severity suggests that improvised padding probably is not an effective prevention or treatment for tail-base lesions.

The presence of dirt was associated with more severe lesions. This could have been through increasing the likelihood of wounds becoming infected, since the relative risk ratio suggested that dirt moderately but significantly increased the chance of infection by a factor of 1.6. Dirt might also have contributed slightly to the early stages of lesion formation, perhaps by increasing the abrasiveness of the strap’s surface, although we found no relationship between the presence of dirt and strap roughness. Also, since soiling sometimes contained faecal matter, skin irritation could have increased lesion severity (Pascoe and Knottenbelt, 1999; Scott and Miller, 2003). In view of the
correlational nature of this study, it should be considered that dirt might be the consequence, rather
than the cause, of lesions becoming more severe; severe lesions could have attracted dirt onto the
strap due to their moist exudates. We found no correlation between the presence of dirt and the
straps’ moisture scores, but this possibility cannot be ruled out.

Strap material is often suggested to be an important factor in lesion formation, so it was an
unexpected finding that none of the material descriptors, such as roughness, moisture or width,
showed any trends with lesion severity. However, cotton sheet and fleece straps were found
significantly more often on donkeys with more severe lesions and, conversely, synthetic rope or
webbing was found on those with less severe lesions. In general, synthetic materials were associated
with less severe lesions than cotton materials.

In humans, cotton clothing absorbs sweat, unlike most synthetic materials, but it is also
relatively abrasive, so synthetic materials may reduce the occurrence of friction-related conditions
such as ‘jogger’s nipple’ (Mailler and Adams, 2004) and blisters (Herring and Richie, 1993; Zhong
et al., 2006). On the other hand, some medical texts recommend cotton for preventing these lesions
(Basler et al., 2004), so it appears that further investigation might be required.

The occurrence of less severe lesions with synthetic rope is surprising, since nylon ropes
(which were included in this category) are often thought to be a cause of harness-related lesions
(Gebreab, 1997; Svendsen, 1997); ropes generally have a narrow contact surface area so they can cut
into the flesh. Here, only two of the 15 ropes were thin (less than 1 cm diameter), while 10 had a
moderate width of 1-3 cm. However, most (13/15) were described as having a rough surface, so they
should have been abrasive. This was a heterogeneous group of materials and the complex
relationship between harness materials and their propensity to cause lesions requires further
investigation into which materials cause damage and why. Some of this work should be carried out
on equines, rather than relying on human studies, because skin friction coefficients vary enormously
even between different regions of the human body, especially between hairy and glabrous skin (Zhong et al., 2006), so skin friction can also be expected to differ widely between different species.

Few indirect husbandry or human factors appeared to relate to lesion development. When attendants stated that they changed the rump strap at a fixed interval, lesions were more severe than if they changed it when it broke or caused injury. The latter finding implies an effective course of action for allowing newly formed lesions to heal. However, waiting until the strap breaks seems an unlikely strategy for treating lesions, so it may be a type I error. Alternatively, with the language barrier, strap ‘breakage’ might mean anything from the strap snapping to it becoming worn and ragged. If these results are replicable, they might suggest that lesions were less severe in donkeys whose attendants monitored the state of their straps, compared with those whose attendants’ harness maintenance routine did not consider the state of the straps.

There was also a non-significant trend suggesting that donkeys that were hit by their attendants had more severe lesions than those that were not. This could reflect a generally less considerate attitude of these attendants towards these donkeys, perhaps reducing donkey health through poorer husbandry generally or through donkeys’ fear of their handlers (Rushen et al., 1999; Hemsworth, 2003). Equally, it could be that donkeys with lesions travelled more slowly and the attendants responded by hitting them, but again we found no evidence that lesion severity related to work output.

If any other human or husbandry effects did exist, it may have been that their interactions with other factors made them too complex or subtle to be detectable with the current sample size and variation. Also, because most of the husbandry and historical information relied on an interview questionnaire, some aspects of the data could have been unreliable if questions were misunderstood, or perceived as being value-laden by the attendants. The lack of any relationship between lesion
severity and whether attendants reported that they would rest their donkey if it had a lesion, suggests
that this may have occurred in some cases.

Part of our approach towards reducing the prevalence and severity of tail lesions was to
assess whether there was a work incentive associated with having no lesions (Starkey, 1997; Pearson
et al., 1999). In fact we found no association, in either direction, between lesion severity and work
output. The lack of relationship could be because the donkeys had welfare problems other than tail
lesions. For example, an earlier survey revealed that 10% had an abnormal gait and 69% had swollen
flexor tendons and fetlock joints (Whay et al., 2006). Compared with tail-base lesions, limb problems
might be caused more directly by the frequency of journeys taken and might render the donkeys
physically less able to complete the journeys without stopping or stumbling.

The tourists’ motivations for choosing donkeys also showed that there was little concern for
the donkeys’ welfare, perhaps through a lack of awareness. Most tourists hired the first donkey they
came across, but 27% chose a strong, healthy donkey, which could have been through concern for
the animals’ welfare but also through the tourist desiring a donkey that they believed could carry
their weight without difficulty.

On the basis of these findings, lesion prevalence and severity might be reduced by avoiding
tight, padded straps, especially those made of cotton sheets or fleece and by cleaning straps
frequently. These interventions would be relatively easy and effective changes to implement, since
they should require little skill and few resources (Krecek and Waller, 2006). Further research into the
effects of different strap materials will be required, however, before any confident conclusions can
be drawn.

Factors reported to be important in the literature should also not be neglected simply because
they did not reach statistical significance in this dataset from a restricted population of donkeys at a
single time point. For example, a factor that we did not assess was the presence of sharp edges or
protrusions on the straps, but these would obviously greatly increase the likelihood of direct physical
trauma by puncturing or cutting the skin, so straps should have smooth, rounded contours (Dibbitts,
1997; Meinander and Varheenmaa, 2002). Moisture showed no relationship with lesion severity in
this study, but it can increase the friction coefficients and abrasiveness of materials, increase the
permeability of (human) skin and encourage bacterial growth (Zimmerer et al., 1986; Zhong et al.,
2006). Therefore, straps should be allowed to dry fully after being washed and, under sweaty or
humid working conditions, straps combining a synthetic layer against the skin to wick away moisture
with an absorbent outer layer could be considered (Elsner et al., 2003).

Conclusion

This risk factor analysis of a long-standing problem has generated potentially useful
information to stimulate more targeted interventions (Greenland et al., 2004). It demonstrates how
epidemiological studies can yield potentially useful information to help combat problems where
‘common sense’ solutions have been unsuccessful. Confirmation or refutation of our findings will
only be realised through monitoring of controlled intervention strategies or through purpose-designed
experiments.

Acknowledgements

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References

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Table 1
Condensed list of the data collected through observations and interviews

<table>
<thead>
<tr>
<th>General aspect under survey</th>
<th>Specific variables assessed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Donkey health and behaviour</td>
<td>Age, Gender, Body condition (very thin-very fat), Skin tent duration, General attitude (apathy or alertness), Response to observer approach, walking down donkey’s side and chin contact, Gait when climbing/descending steps</td>
</tr>
<tr>
<td>Rump strap</td>
<td>Width, Attachment to saddle (either side or central), Fit (tight/loose), Material, Padding, Cleanliness, Surface texture (roughness), Moisture, Position, tightness and visible rubbing when climbing/descending steps, Saddle position when climbing/descending steps</td>
</tr>
<tr>
<td>Observations of donkey at rest</td>
<td>Food, water and shade availability, Saddle removal, Evidence of human-animal bond with attendant</td>
</tr>
<tr>
<td>Attendant behaviour up/down steps</td>
<td>Patience, vocal volume and roughness of handling, Stick carrying, Beating</td>
</tr>
<tr>
<td>Tourist characteristics</td>
<td>Heel and body position when climbing/descending steps (rear view), Posture when climbing/descending steps (side view)</td>
</tr>
<tr>
<td>Attendant interview</td>
<td>Age of attendant, Length of time working with donkeys generally and this donkey in particular, Action taken if donkey bites someone, e.g., punishment, Problems with the donkey that would prevent the attendant using the donkey, e.g., lameness or sores, Reported location donkey is left in when not working and reasons for choosing that place; Actions taken with donkey at the end of working day, Work output, Reported stick/goad use, use of vocal commands and obedience of donkey, Number of times water is offered to the donkey and number of times donkey drinks each day, Attendant awareness of whether donkey has a sore under the tail/elsewhere on its body, Perceived methods for preventing/curing lesions, Frequency of grooming and cleaning under tail, Attitude regarding lesions, Discussion about donkey’s lesions with other attendants, Reported frequency of changing rump strap</td>
</tr>
<tr>
<td>Veterinary care</td>
<td>Perceived likelihood that tail sores heal after veterinary treatment, Perception of whether or not advice or practical training about preventing tail sores is given by the Brooke, Perceived proportion of responsibility for donkey care that lies with the attendant or the Brooke, Length of time spent by Brooke staff with attendant</td>
</tr>
</tbody>
</table>

These data reflect a strategic research approach similar to that described in a related paper by Pritchard and colleagues (2005). More details of the level of analysis within each variable are available in the questionnaire (available as online supplementary material) or upon request from the authors.
Table 2  
Details of the lesion severity scoring system

<table>
<thead>
<tr>
<th>Severity score</th>
<th>Description</th>
<th>N</th>
<th>Number with discharge and/or inflammation</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>No lesion</td>
<td>23</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>Superficial or healed lesion, with surface area less than 0.5 cm x 0.5 cm</td>
<td>9</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>Superficial or healed lesion, with surface area between 0.5 cm x 0.5 cm and 1 cm x 1 cm or Skin and immediate subcutaneous layer broken, with surface area less than 0.5 cm x 0.5 cm</td>
<td>16</td>
<td>0</td>
</tr>
<tr>
<td>3</td>
<td>Superficial or healed lesion, with surface area larger than 1 cm x 1 cm or Deep lesion, with surface area less than 0.5 cm x 0.5 cm</td>
<td>11</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>Skin and immediate subcutaneous layer broken, with surface area between 0.5 x 0.5 cm and 1 x 1 cm</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>5</td>
<td>Skin and immediate subcutaneous layer broken, with surface area larger than 1 x 1 cm or Deep lesion, with surface area between 0.5 x 0.5 cm and 1 x 1 cm</td>
<td>18</td>
<td>18</td>
</tr>
<tr>
<td>6</td>
<td>Deep lesion, with surface area larger than 1 x 1 cm</td>
<td>4</td>
<td>4</td>
</tr>
</tbody>
</table>

The scores were derived from the product of the lesion depth and surface area scores. Exploratory analyses also used an extended version, which included signs of wound infection (discharge and/or inflammation), but this produced very similar results to this simpler scoring system because the signs of infection were so tightly related to the size and depth of the wound (all wounds scoring 4 or more showed signs of infection, yet no wounds scoring less than 3 showed such signs). Discharge and inflammation generally occurred together (22/29 cases). Descriptions in parentheses are those that were never observed in the donkeys at Petra and there was one missing value.
<table>
<thead>
<tr>
<th>Response</th>
<th>Predictive comparison (n)</th>
<th>Median (interquartile range)</th>
<th>Difference (95% confidence interval)</th>
<th>U</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lesion severity score</td>
<td>Thick or partial padding (11) vs no padding (18)-tight straps only</td>
<td>5.0 (2.0-5.0) vs 0.0 (0.0-2.75)</td>
<td>3.0 (0.001-5.0)</td>
<td>44.5</td>
<td>0.010</td>
</tr>
<tr>
<td></td>
<td>Thick or partial padding (11) vs thin padding (8)-tight straps only</td>
<td>5.0 (2.0-5.0) vs 1.5 (0.25-2.0)</td>
<td>3.0 (0.001-4.0)</td>
<td>17.0</td>
<td>0.023</td>
</tr>
<tr>
<td></td>
<td>Unclean (31) vs clean (53) straps</td>
<td>5.0 (2.0-5.0) vs 2.0 (0.0-3.0)</td>
<td>2.0 (1.0-3.0)</td>
<td>431.0</td>
<td>0.001</td>
</tr>
<tr>
<td></td>
<td>Cotton sheets (14) vs synthetic rope (21)</td>
<td>5.0 (1.75-6.0) vs 1.0 (0.0-2.0)</td>
<td>3.0 (1.0-4.0)</td>
<td>55.0</td>
<td>0.001</td>
</tr>
<tr>
<td></td>
<td>Fleece (13) vs synthetic rope (21)</td>
<td>3.0 (2.0-5.0) vs 1.0 (0.0-2.0)</td>
<td>2.0 (0.0-3.0)</td>
<td>60.5</td>
<td>0.006</td>
</tr>
<tr>
<td></td>
<td>Cotton sheets (14) vs synthetic webbing (17)</td>
<td>5.0 (1.75-6.0) vs 2.0 (0.0-3.0)</td>
<td>2.0 (1.0-3.0)</td>
<td>61.0</td>
<td>0.023</td>
</tr>
<tr>
<td></td>
<td>All cotton straps (34) vs all synthetic straps (42)</td>
<td>2.5 (1.0-5.0) vs 1.5 (0.0-3.0)</td>
<td>2.0 (1.0-2.0)</td>
<td>423.0</td>
<td>0.002</td>
</tr>
<tr>
<td></td>
<td>Strap changed when broken (42) vs at fixed intervals (16)</td>
<td>3.0 (0.0-4.0) vs 5.0 (3.0-5.0)</td>
<td>1.0 (0.0-3.0)</td>
<td>193.0</td>
<td>0.011</td>
</tr>
<tr>
<td></td>
<td>Strap changed when injures donkey (7) vs at fixed intervals (16)</td>
<td>2.0 (0.0-4.0) vs 5.0 (3.0-5.0)</td>
<td>2.0 (0.001-5.0)</td>
<td>25.5</td>
<td>0.039</td>
</tr>
<tr>
<td></td>
<td>Attendant observed (54) vs not observed (31) hitting donkey</td>
<td>5.0 (4.0-6.0) vs 4.0 (3.0-6.0)</td>
<td>1.0 (0.0-2.0)</td>
<td>628.5</td>
<td>0.052</td>
</tr>
<tr>
<td></td>
<td>Attendant perception that sores do heal (65) vs do not heal (19) after treatment</td>
<td>3.0 (0.0-4.0) vs 4.0 (3.0-5.0)</td>
<td>1.0 (0.0-2.0)</td>
<td>369.5</td>
<td>0.007</td>
</tr>
<tr>
<td>Body condition score</td>
<td>Tourists choosing first available donkey (25) vs strong/healthy donkey (19)</td>
<td>2.5 (2.0-3.0) vs 3.0 (2.5-3.5)</td>
<td>0.5 (0.0-0.5)</td>
<td>156.5</td>
<td>0.048</td>
</tr>
</tbody>
</table>
Table 4
Details of the materials used for the straps. The straps are separated by the degree of padding and the median (interquartile range) lesion severity scores are also reported for information

<table>
<thead>
<tr>
<th>Padding score</th>
<th>Material type</th>
<th>n</th>
<th>Median lesion severity (interquartile range)</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>Synthetic webbing</td>
<td>7</td>
<td>2 (0-3)</td>
</tr>
<tr>
<td></td>
<td>Synthetic blanket</td>
<td>3</td>
<td>0 (0-3)</td>
</tr>
<tr>
<td></td>
<td>Synthetic rope</td>
<td>8</td>
<td>0.5 (0-2)</td>
</tr>
<tr>
<td></td>
<td>Cotton sheet</td>
<td>9</td>
<td>2 (1.5-5.5)</td>
</tr>
<tr>
<td></td>
<td>Cotton webbing</td>
<td>1</td>
<td>0 (NA)</td>
</tr>
<tr>
<td></td>
<td>Cotton strips</td>
<td>4</td>
<td>1 (0-3.5)</td>
</tr>
<tr>
<td></td>
<td>Fleece</td>
<td>2</td>
<td>3.5 (NA)</td>
</tr>
<tr>
<td></td>
<td>Wool</td>
<td>1</td>
<td>0 (N/A)</td>
</tr>
<tr>
<td></td>
<td>Composite (cotton strips and synthetic rope)</td>
<td>1</td>
<td>0 (NA)</td>
</tr>
<tr>
<td>Thin</td>
<td>Synthetic webbing</td>
<td>5</td>
<td>0 (0-3.5)</td>
</tr>
<tr>
<td></td>
<td>Synthetic blanket</td>
<td>0</td>
<td>NA</td>
</tr>
<tr>
<td></td>
<td>Synthetic rope</td>
<td>3</td>
<td>1 (0-2)</td>
</tr>
<tr>
<td></td>
<td>Cotton sheet</td>
<td>3</td>
<td>5 (1-6)</td>
</tr>
<tr>
<td></td>
<td>Cotton webbing</td>
<td>0</td>
<td>NA</td>
</tr>
<tr>
<td></td>
<td>Cotton strips</td>
<td>1</td>
<td>2 (NA)</td>
</tr>
<tr>
<td></td>
<td>Fleece</td>
<td>3</td>
<td>3 (0-4)</td>
</tr>
<tr>
<td></td>
<td>Wool</td>
<td>0</td>
<td>NA</td>
</tr>
<tr>
<td></td>
<td>Composite (cotton strips, cotton webbing, fleece and/or synthetic rope)</td>
<td>4</td>
<td>3.5 (2-5)</td>
</tr>
<tr>
<td>Thick or partial</td>
<td>Synthetic webbing</td>
<td>5</td>
<td>3 (1.5-4)</td>
</tr>
<tr>
<td></td>
<td>Synthetic blanket</td>
<td>1</td>
<td>3 (NA)</td>
</tr>
<tr>
<td></td>
<td>Synthetic rope</td>
<td>4</td>
<td>0.5 (0-1)</td>
</tr>
<tr>
<td></td>
<td>Cotton sheet</td>
<td>4</td>
<td>3.5 (1.25-5.75)</td>
</tr>
<tr>
<td></td>
<td>Cotton webbing</td>
<td>2</td>
<td>3.5 (NA)</td>
</tr>
<tr>
<td></td>
<td>Cotton strips</td>
<td>6</td>
<td>3.5 (1-5)</td>
</tr>
<tr>
<td></td>
<td>Fleece</td>
<td>4</td>
<td>4 (0.75-5)</td>
</tr>
<tr>
<td></td>
<td>Wool</td>
<td>2</td>
<td>5 (NA)</td>
</tr>
<tr>
<td></td>
<td>Composite (cotton strips, fleece and/or synthetic rope)</td>
<td>3</td>
<td>3 (2-5)</td>
</tr>
</tbody>
</table>

NA: Not applicable
Table 5

Perceived measures for the prevention and treatment of tail-base lesions as reported by donkey attendants at Petra

<table>
<thead>
<tr>
<th>Suggested solution</th>
<th>Number of donkey attendants making suggestion</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Prevention of lesions</strong></td>
<td></td>
</tr>
<tr>
<td>Use a smooth strap material</td>
<td>38</td>
</tr>
<tr>
<td>Use a smooth and padded strap</td>
<td>23</td>
</tr>
<tr>
<td>Change the strap regularly</td>
<td>21</td>
</tr>
<tr>
<td>Use a spongy strap material</td>
<td>6</td>
</tr>
<tr>
<td>Use medicine</td>
<td>1</td>
</tr>
<tr>
<td>Use a loose strap</td>
<td>1</td>
</tr>
<tr>
<td>Clean the strap regularly</td>
<td>1</td>
</tr>
<tr>
<td><strong>Treatment of lesions</strong></td>
<td></td>
</tr>
<tr>
<td>Take the donkey to the Brooke’s veterinary clinic</td>
<td>58</td>
</tr>
<tr>
<td>Buy medicine for the lesion</td>
<td>23</td>
</tr>
<tr>
<td>Change the strap</td>
<td>9</td>
</tr>
<tr>
<td>Apply padding to the strap</td>
<td>5</td>
</tr>
<tr>
<td>Loosen the strap</td>
<td>1</td>
</tr>
<tr>
<td>No treatment</td>
<td>1</td>
</tr>
</tbody>
</table>

The sum total is more than the total of 86 attendants because they could each suggest more than one solution.
**Figure legends**

Fig. 1. Donkeys at Petra. (A) Tight, padded synthetic blanket strap. (B) Tight unpadded cotton webbing strap. (C) Loosened, cotton strip strap, partially padded with fleece. (D) Example of a lesion that would score 6 (the maximum) on the severity scale.

Fig. 2. Median (+/− interquartile range) lesion severity score for different amounts of padding on tight or loose straps. Straps that were classed as neither tight nor loose are not shown here because there were only 12 donkeys with such straps (compared with 37 and 36 tight and loose straps, respectively), giving too few individuals to assess the effects of padding for that class. Analyses were carried out by combining the partial and thick padding categories due to small sample size, but they are displayed separately here for completeness.

Fig. 3. Histogram of the relationship between the cleanliness of donkeys’ rump straps and the severity scores of tail-base lesions. Of the 23 donkeys without lesions, 19 had clean rump straps. In contrast, all four donkeys with the most severe lesions (scoring 6) and 13/18 donkeys with lesions scoring 5 had dirty straps.

Fig. 4. The median (+/− interquartile range) lesion severity score for rump straps made from different types of materials. Materials constituting fewer than five straps (cotton webbing: n = 3; wool: n = 3; and synthetic blanket: n = 4) and straps made from a mixture of materials (n = 8) are not shown.
Figure 2

Thick/Partial/Thin/None

Quantity of padding

Lesion severity score

Fit of strap

Loose

Tight

None | Thin | Partial | Thick

0 | 1 | 2 | 3 | 4 | 5 | 6

6 5 4 3 2 1 0
Figure 4

![Box plot](image)

- Synthetic rope (n=15)
- Synthetic webbing (n=17)
- Cotton strips (n=11)
- Fleece (n=9)
- Cotton sheets (n=16)

Lesion severity score