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BRIEF COMMUNICATION: Effects of road transport, including stationary periods, on environmental conditions and physiological responses of sheep

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INTRODUCTION

Livestock transport exposes animals to challenging environmental conditions that can result in welfare compromise. During road transport, sheep can be exposed to a high temperature in combination with a high humidity, expressed as a temperature-humidity index (THI), that can lead to thermal stress (Fisher *et al.*, 2002; Fisher *et al.*, 2004). In practice, these conditions can result in mortalities. Lambs are particularly susceptible. Extreme conditions are more likely to occur on journeys where there is little air movement through the stock crates. For example, during an inter-island ferry crossing, when vehicles carrying livestock are parked inside the hull of the ferry rather than on the outside deck (Fisher *et al.*, 2004).

The focus of our previous studies has been to identify environmental conditions leading to thermal stress in lambs during such journeys. Fisher *et al.* (2002) reported THI values ranging from 75 to a maximum of 91 during a stationary period. Such conditions are known to predict significant thermal stress (Silanikove, 2000). Although THI is a commonly used indicator of heat, animal-based measures are required in order to assess welfare impacts. Individuals vary in their ability to tolerate thermal load depending on characteristics such as age, breed, live weight and wool length.

The aim of this study was to use a similar design to that of Fisher *et al.* (2002) to determine the effects of thermal conditions experienced during simulated inter-island ferry crossings on the physiological responses of rising two-year-old ewes.

MATERIALS AND METHODS

Ethics

The protocol and conduct of this study were approved by the Ruakura Animal Ethics Committee, Hamilton.

Animals and procedure

In early February 2005, four days prior to transport, a total of 24 rising two-year-old (two-tooth) Coopworth ewes with an average weight of 58 kg and an average wool length of 45 mm, were allocated to two equal sized treatment groups, "Transport" and "Yards" (n = 12 per treatment) and managed separately at the AgResearch, Winchmore Farm. In accordance with best practice for transporting livestock, the ewes were withheld from pasture overnight prior to treatment, with access to water, in order to reduce gut fill. The Transport treatment was a simulated inter-island ferry crossing that included transport for 170 km, followed by a one hour stationary period parked outdoors, a three hour period parked inside an enclosed shed, then transport for a further 70 km. As a control the Yards treatment involved penning the 12 ewes in a covered yard with a stocking density of 1.5 m^2/ewe for the equivalent time that the Transport group were penned in the truck. The vehicle used to transport the ewes was a standard 3-deck truck unit and a 4-deck trailer unit that was filled with lambs at a standard stocking density (0.23 m^2/lambs), typical of normal commercial practice. Study sheep were transported in the pen that Fisher *et al.*, (2002) previously identified as having the highest THI values in the trailer unit, the middle pen of the middle deck.

Air temperature (°C) and relative humidity (%) were recorded every five minutes with HOBO Pro Dataloggers (Onset Computer Corporation, Bourne, Massachusetts, USA). Loggers were placed in the yards and inside the study pen at approximately animal head height. Internal body temperature (°C) was recorded using temperature loggers (Vemco Ltd., Shad Bay, Nova Scotia, Canada) inserted into the vagina of eight of the 12 ewes from each treatment. Body temperature was recorded every five minutes before, during and after transport. The THI was used as an indicator of thermal comfort and calculated according to the formula used by Igono *et al.* (1992) as follows:

$$THI = (1.8 \times T + 32) - ((0.55 - 0.0055 \times RH) \times (1.8 \times T - 26))$$

where T = Air temperature (°C), RH = Relative humidity (%)

Blood samples were taken via jugular venepuncture before the Transport group were loaded and on return to the farm after unloading. All blood samples were collected into tubes containing lithium heparin anticoagulant, placed on ice and centrifuged for 10 minutes at 2,500 rpm. Plasma was stored at -20°C until assayed for cortisol concentrations.

FIGURE 1: The temperature-humidity index (THI) recorded inside the study pen in the truck during a road transport procedure that simulated an inter-island ferry crossing and in the yards where the control group were held for the same time interval.

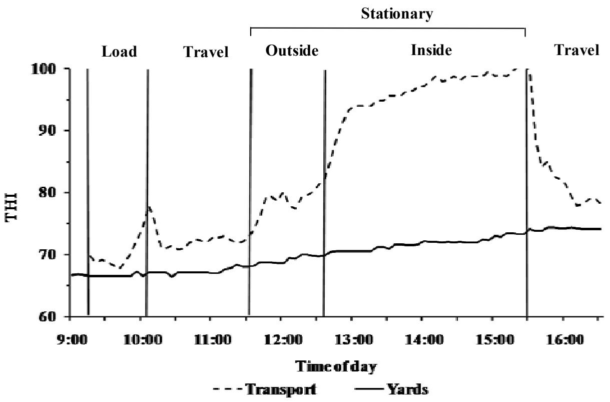
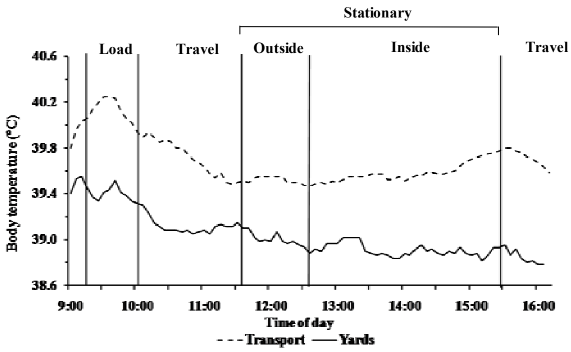


FIGURE 2: Body temperature (°C) of eight ewes recorded during a road transport procedure that simulated an inter-island ferry crossing and another group of six ewes penned in a covered yard for the same time interval.



Statistical analysis

The mean body temperature (± standard error of the mean) was calculated during the following events: loading onto the truck, first road journey, truck parked outdoors, truck parked inside shed, second road journey. A one-way ANOVA was used to compare overall treatment differences in the change in body temperature from the previous event for each period and in cortisol concentrations before and after transport. The THI during the transport procedures are presented descriptively in Figure 1. Due to equipment failure, body temperature profiles for two animals in the Yard group, were not included.

RESULTS AND DISCUSSION

The THI values started to increase when the truck was parked outdoors (Figure 1). The THI then increased rapidly at the start of the indoor stationary period and remained between 80 and 100 with a maximum of 37.9°C at 100% relative humidity, until the truck re-commenced travelling. These THI values, which are similar to those reported previously (Fisher *et al.*, 2002), are likely to be due to the lack of airflow through the pen (Fisher *et al.*, 2004), and predict moderate to severe thermal stress (Silanikove, 2000).

The change in body temperature was greater ($P < 0.05$) for the Transport group (+0.8 ± 0.1°C) than for the Yards group (+0.3 ± 0.1°C) during loading (Figure 2). This increase in body temperature would have been likely due to a combination of the stress associated with loading and the increased activity at this time. Body temperature decreased once the sheep were loaded and the truck began moving, creating increased airflow. During the stationary period inside the shed, the change in body temperature was greater ($P < 0.05$) for the Transport group (+0.1 ± 0.0°C) than for the Yards group (-0.1±0.1°C). Body temperature peaked towards the end of the period inside the shed, which was probably due to the steadily increasing THI and delayed effects of heat on animal responses. All of the Transport group had body temperatures ranging between 39.0 and 40.0°C, except for one sheep that reached 41.1°C, while the truck was inside the shed. Although body temperature did not reach levels (≥42°C) that are considered to be dangerously high (Marai *et al.*, 2007), a longer period of time exposed to such high THI levels may pose a welfare risk.

It was not possible to measure respiration rate or panting in an objective way during this study. Both are a typical thermoregulatory response to heat challenge in sheep. When physiological mechanisms, such as panting, fail to negate the excessive heat load, body temperature increases (Marai *et al.*, 2007). In future, this information would be useful and may be a better index of heat load than body temperature *per se*, given the lag in body temperature changes. Cortisol concentrations increased during transport by 7.9 ± 3.0 ng/mL, and decreased during yarding by 7.8 ± 3.0 ng/mL ($P < 0.001$), indicating an increase in hypothalamic-pituitary-adrenal axis activity associated with the stress of the transport experience, including unloading.

In conclusion, the absence of sufficient airflow during the indoor stationary period caused high THI values in the truck that were above levels that have been reported as leading to moderate to severe thermal stress. THI data provide further evidence that the risk of heat stress is high during hot, stationary periods. While body temperature showed a corresponding increase, it was less than the rise during the loading phase. It is not clear why THI values that previously have been associated with high thermal stress had a relatively minor effect on body temperature. Prior adaption to hot summer conditions may be one possible explanation. In addition, during stationary periods such as a ferry crossing, further stressors associated with the movement of the ship, fumes and unfamiliar environment may add to the stress that sheep are exposed to. It was not possible to simulate these added stressors in this study. If stationary periods cannot be avoided, trucks should be parked where there is shade or sufficient airflow to reduce the risk of thermal stress to the animals in the pens.

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