Effect of macroenvironment and microenvironment temperature and humidity on the risk of respiratory disease in pre-weaned dairy calves during summer months

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Introduction

Environmental factors, such as heat stress, have the potential to adversely affect the physiology, passive immunity, and growth of pre-weaned dairy calves, increasing their risk of respiratory disease. The effect of heat stress on the risk for bovine respiratory disease (BRD) may be in part mediated through housing, ventilation, and management factors such as heat-abatement practices. As a result, there may be differences in meteorological measures recorded in the calf-rearing area or macroenvironment, and within a calf's enclosure or microenvironment. Further investigation of the relationship between calf environment and respiratory disease can guide best management practices and improve calf health and future production. The objective of this cohort study was to evaluate the association between exposure to temperature and humidity measured at the macroenvironment and microenvironment, and the risk of BRD in pre-weaned dairy calves.

Materials and Methods

A cohort of 253 pre-weaned Holstein and Jersey calves from 4 premises in the San Joaquin Valley of California was followed for 5 months during the summer and evaluated for respiratory disease using the California BRD scoring system for pre-weaned dairy calves. Meteorological conditions were measured at both the calf-rearing area and the within-hutch environment. Mixed effects logistic regression and survival analysis were used to analyze the association between daily environmental measures of temperature, relative humidity, and temperature-humidity index (THI) and the outcome BRD adjusted for dairy premises, age, gender, and breed.

Results

Daily maximum temperatures averaged 96.4°F (35.8°C) and ranged from 75.2°F to 107.6°F (24°C to 42°C); in contrast, the within-hutch daily maximum temperature averaged 95.7°F (35.4°C) and ranged 75.2°F to 107.6°F (25°C to 42°C). Daily maximum humidity for the microenvironment averaged 78.2% and ranged from 28% to 100%. There was a significant positive association between daily maximum temperature and BRD in both the calf's macroenvironment (odds ratio (OR)=1.12; 95% CI: 1.03, 1.22), and microenvironment (OR=1.18; 95% CI: 1.01, 1.39). Estimated hazard rates (HR) also showed a significant positive association between daily maximum temperature and BRD in both the macroenvironment (HR=1.13; 95% CI: 1.05, 1.21), and microenvironment (HR=1.12; 95% CI: 1.06, 1.18). Daily maximum relative humidity in a calf's microenvironment was significantly associated with BRD (OR=1.05; 95% CI: 1.00, 1.10); however, the hazard rate of BRD was not associated with relative humidity. There was no association between the microenvironment's maximum THI and odds or hazard rate of BRD

Significance

Daily maximum temperature was significantly associated with BRD when measured at both the macroenvironment and microenvironment of pre-weaned dairy calves. However, the magnitude of the association between maximum daily temperature and BRD was greater when predicted using microenvironment compared to macroenvironment temperatures. This may be explained by conditions recorded in close proximity to the calf being more representative of each calf's exposure, particularly as orientation, position within the hutch area or presence of supplemental shading may lead to variation in hutch environments compared to the general calf raising area. An increase in daily maximum relative humidity was also associated with an increase in odds of BRD at the microenvironment level. However, when peak daily THI, a heat-stress index incorporating both temperature and humidity, was used as a microenvironment predictor for BRD in this study, it was not significant. One possible explanation for the lack of a significant association between THI at the microenvironment and BRD in calves in the current study is the fairly low relative humidity resulting in lower and less variable THI values. These findings suggest that in regions with hot and dry summer months, as in the San Joaquin Valley of California, daily maximum temperatures may be a more useful indicator of heat stress and hence, a better BRD predictor than THI