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Invited review: Influence of climatic conditions on the development, performance, and health of calves

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ABSTRACT

The objective of this review is to provide the reader with an overview of thermoregulatory mechanisms and the influence of climatic conditions in different housing systems on the development, performance, and health of calves. Thermic stress is observed in association with extreme temperatures and large temperature variations, but other variables such as relative humidity and wind speed can also contribute to thermic stress. Thermoregulation in calves is similar to that in adult cattle, but especially dystocial calves are more prone to heat loss. Heat or cold stress results in direct economic losses because of increased calf mortality and morbidity, as well as indirect costs caused by reduced weight gain, performance, and long-term survival. The climatic conditions in a variety of housing systems, associated health problems, and strategies to mitigate thermic stress are discussed in this review. The goal of housing is to alleviate the effect of climate on calves and provide a microclimate. Adequate ventilation with fresh air is essential to reduce respiratory disease. Common practices such as raising calves in individual outdoor enclosures have been challenged lately. Recent research seeks to evaluate the suitability of group housing under practical, economic, and animal welfare considerations. Limited results for reducing thermic stress can be achieved by simple measures such as shades or shelter, but additional heat or cold stress relieving strategies can be required depending on the housing system.
Key words: calf, climate, thermoregulation, heat stress, cold stress

INTRODUCTION

Thermoregulation is the ability of homeothermic animals to keep their body temperature within a certain range despite being exposed to different ambient temperatures (Bligh, 1998). A physiological core temperature is maintained by generating metabolic heat as well as exchanging heat with the environment (Da Silva, 2012).

Animals are able to adjust to adverse climate by means of acclimatization and adaptation (Roy and Collier, 2012). Extreme climatic conditions that cannot be compensated by thermoregulatory mechanisms result in thermic stress. Thermic stress in calves has a negative effect on animal welfare (Silanikove, 2000) and causes direct economic losses in the form of mortality and morbidity, and indirect costs caused by reduced weight gain, performance, and long-term survival (Virtala et al., 1996; Donovan et al., 1998; Snowder et al., 2006). Because some subspecies and breeds are better adapted to a hot climate (Cartwright, 1955; Silva et al., 2013), efforts have been made to create heat-resistant and high-performing crossbreeds, but with varying results (McDowell, 1985; Rutledge, 2001; Eberhardt et al., 2009).

Different housing systems have been developed to protect calves from extreme climatic conditions and thermic stress. Depending on the climate, culture, and intended use of animals (e.g., beef versus dairy) these include open range, shelters, pens, or hutches, and naturally or mechanically ventilated stables (Seedorf et al., 1998; Moran, 2002; Marcé et al., 2010). Whereas some housing systems principally succeed in providing thermal comfort to calves, other problems, such as poor air quality, might arise from their use. Ongoing research aims to identify the best housing system for a particular climate.

Diarrhea and respiratory disease, the 2 most common health problems when raising calves, are typically caused by multiple factors, with climate and housing system playing an important role in the etiology (Roy, 1980; Barrington et al., 2002; Gorden and Plummer, 2010; Walker et al., 2012). The incidence of respiratory diseases tends to be higher in calves reared in mechanically ventilated barns than in calves housed with natural ventilation or in outdoor enclosures (Okamoto et al., 1993; Wójcik et al., 2012; Table 1).

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Table 1. Selected studies analyzing the influence of housing type on calf performance[1]

Study	Animals	Season	Region	Duration	Treatment	Control	Weight gain	Feed intake	Respiratory disease incidence	Diarrhea incidence
Davis et al. (1954)	32 newborn Jersey or crossbred calves	Winter	Washington, US	2 yr; up to 6 mo/calf	Outdoor individual portable pen	Closed barn	Pos	NA	Neg	Neg
Hanekamp et al. (1994)	13 batches of 80 red-and-white bull calves	All seasons	Netherlands	5 yr; 6 mo/calf	Open barn	Closed barn	—	—	—	NA
Hepola et al. (2006)	80 male Frisian and Ayrshire calves	All seasons	Finland	5 yr; 12 wk/calf	Outdoor group housing	Indoors (cow barn)	Neg	—	NA	NA
Jorgenson et al. (1970)	60 Holstein calves	All seasons	North Dakota, US	26 wk/calf	Outdoor hutches/open sheds	Heated barn	—	—	—	—
McKnight (1978)	68 newborn male Holstein calves	All seasons	Ontario, Canada	3 yr; 49 d/calf	Outdoor movable pen	Stall in enclosed barn	—	Pos	—	Neg.
Murley and Culvahouse (1958)	122 female calves	All seasons	North Carolina, US	4 yr; 16 wk/calf	(a) open shed; (b) portable pen	Conventional barn	—	—	Neg	—
Nilsson (2012)	793 heifer calves	All seasons	Sweden	4 yr	Outdoor group hutches	Naturally ventilated barn	NA	NA	Neg	Neg
Okamoto et al. (1993)	9 male Holstein calves	Winter	Japan	3 winters	Outdoor hutch	Heated stable	—	—	Neg	—
Richard et al. (1988)	42 Holstein calves	Fall to spring	Pennsylvania, US	NA	Outdoor individual hutches	Mechanically ventilated barn	Pos	—	Neg	NA
Wójcik et al. (2012)	90 Holstein bull calves	Summer/fall	Germany	84 d	Group igloo hutches	Calf barn (group pens)	Pos	Pos	Neg	NA

[1]POS = treatment has a positive effect on parameter compared with control. NEG = treatment has a negative effect on parameter compared with control. — = treatment has no effect on parameter compared with control. NA = not analyzed in this study.