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Heat waves related mortality in dairy cows

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Previous studies demonstrated that the risk of death for dairy cows is higher during summer compared to other seasons.
The present study was aimed at investigating the effect of heat waves on dairy cows mortality. 46,582 events (deaths) recorded from 1st May to 30th September during a 6-yr period (2002 to 2007) were considered. Mortality data were extracted from the Bovine Spongiform Encephalopathy databases available at the Italian Reference Centre for Animal Encephalopathies (Turin, Italy) and at the National Reference Centre for Animal Welfare (Istituto Zooprofilattico Sperimentale Lombardia ed Emilia Romagna, Brescia, Italy). Data were referred to cows older than 24 months that died on a farm from all causes, were slaughtered in an emergency state, or were sent for normal slaughter but were found to be sick at the preslaughter inspection. The latter two categories accounted for approximately 2% of total deaths.
Mortality counts were categorized by the age of the cows as follows: 24-28, 29-60, 61-96 and 97+ months. Furthermore, on the basis of the geographic localization of the farms, data were also categorized as referred to northern, central or southern Italy. Considering all classes of age, the overall consistencies were 555,852, 169,779 and 162,063 heads yr^{-1} for northern, central and southern Italy, respectively. Average milk yields (kg/lactation on 305 days on average) were 9,226, 8,785 and 7,882 for northern, central and southern Italy, respectively. Average number of lactations/life were 2.44, 2.54, and 2.76 for northern, central and southern Italy, respectively. Data on cows population were obtained from the Italian National Bovine Registry. Weather data (were obtained by 12 weather stations. Heat wave was defined as a period from 1st May to 30th September when the daily maximum temperature exceeded at least the 90th percentile of the reference distribution (1961-1990) for more than three consecutive days.
The relationship between heat wave and mortality was evaluated using a case-crossover design. This approach allows to assess the impact of transient exposures to acute events using only cases and compares each case's exposure during a time period just before the case-defining event (hazard period) with that subject's own exposure in other reference periods (control period). Each subject serves as own control hence measured and unmeasured potential confounding factors are controlled by design. The referent days were selected from the same month and year and matched by day of week to the health outcome. This time-stratified method of selecting comparison days ensures unbiased conditional logistic regression estimates and avoids bias resulting from time trends. Conditional logistic regression models were used to calculate odds ratios (OR) and 95% confidence intervals (CI) stratified by zone and age. The mortality on days post heat wave (1 to 3 days after)

was evaluated to account for possible prolonged effect of heat wave. P-values ≤ 0.05 were considered statistically significant.

The analysis of temperature data pointed out differences among the three geographic zones considered in the study. Daily mean of maximum temperature (°C) were 27.2, 28.3, and 28.4 for the northern, central and southern Italy, respectively. Mean maximum temperature (°C) during heat wave were 30.9, 32.4 and 34.7 for the northern, central and southern Italy, respectively. The number of days classified as heat wave days yr^{-1} were 38, 32 and 18 for the northern, central and southern Italy, respectively. The average length of heat waves were 6.6, 7.3 and 5.4 days for northern, central and southern Italy, respectively.

Pooled data indicated that the mortality was greater ($p<0.001$) during heat waves with an OR of 1,163 (CI: 1.132-1.196). When geographic zones were considered, the OR were 1.186 (CI: 1.149-1.225), 1.105 (CI: 1.036-1.179) and 1.075 (CI: 0.968-1.194) for northern, central and southern Italy, respectively. For the mortality recorded during the three days post heat wave, the model pointed out a significant OR for pooled data; considering the three zones separately, the OR was significant only for northern Italy ($p<0.001$).

When the age was considered, pooled data indicated lower mortality ($p>0.05$) in heat wave for younger cows (age 24-28) with an OR 1.119 (CI: 0.996-1.258). On the other hand, older cows showed a greater risk ($p<0.001$) to die during heat wave with an OR of 1.170 (CI: 1.122-1.219), 1.200 (CI: 1.145-1.259) and 1.092 (CI: 1.022-1.167) for 29-60, 61-96 and 97+ classes of age, respectively.

Considering geographic zones and ages together, the analysis provided conflicting results. Younger cows raised in the northern Italy were less susceptible ($p>0.05$) to heat waves with an OR of 1.062 (CI:0.929:1.213) whereas mortality in older cows was greater ($p<0.001$) with an OR of 1.180 (CI:1.126:1.236), 1.248 (CI:1.182-1.318) and 1.118 (CI: 1.028-1.216) for 29-60, 61-96 and 97+ classes of age, respectively. The mortality in central Italy for the class of age 29-60 was affected ($p<0.05$) by heat waves with a OR of 1.140 (CI:1.024-1.268), whereas it was not significant ($p>0.05$) for the other classes (24-28, 61-90, 97+). Considering southern Italy the younger cows showed the greater ($p<0.05$) mortality during heat waves with a OR of 1.551 (CI:1.043-2.307), whereas that recorded for the older cows was not affected by heat wave in a significant manner.

Results reported herein clearly indicated that heat waves increase the risk of dairy cows mortality and that this effect varies in relation to the age of the cows and to the geographic localization of the farms. On this regard, geographic differences of production systems and climate authorize some interesting speculations which encourage further studies on this topic. Finally, especially in the light of climate scenarios, present results strongly support the adoption of structural, management and pro-active adaptation strategies which may limit heat stress related impairment of animal welfare and economic losses in dairy cow farms.