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Associations between the decrease in bovine clinical mastitis and changes in dairy farmers' attitude, knowledge, and behavior in the Netherlands

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ABSTRACT

The aim of this study was to associate changes in dairy farmers' self-reported attitude, knowledge, and behavior with the decrease in incidence rate of clinical mastitis (IRCM). Farmer-diagnosed clinical mastitis cases were obtained from two surveys conducted before (July 2004–June 2005) and at the end (2009) of a mastitis control program in the Netherlands. Information on farmers' attitude, knowledge, and behavior was also obtained by sending the famers the same questionnaire during both surveys. Multivariable linear regression models identified that the herd level 2004 IRCM explained 28% of the variation in the decrease of IRCM. Changes in farmers' attitude and knowledge, and changes in farmers' behavior additionally explained 24% and 5%, respectively. These results suggest that the way management measures are executed may be at least as important as the fact that they are executed. No control group was available for this study because the intervention was applied at the national level. We therefore do not claim any causal relationships.

Mastitis control programs aim to improve milk quality and udder health in dairy herds. They traditionally investigated the role of certain management measures on the mastitis occurrence in dairy farms and tried to subsequently convince farmers to change their behavior accordingly. Success of national udder health programs therefore heavily depend on the willingness of farmers to adapt their behavior. Strategies to enhance farmers' motivation to improve udder health in their herds might therefore be a very important part of effective mastitis control programs.

Technical information (e.g., advice on how to improve mastitis management) as well as campaigns to motivate farmers to work on udder health were both provided in the Dutch national mastitis control program initiated in 2005 (Lam et al., 2013). This approach was indeed found to change farmers' self-reported attitude, knowledge, and behavior towards udder health (Jansen et al., 2010). Furthermore, improvements in farmers' motivation were related to a decrease in bulk milk somatic cell counts (SCC; Jansen et al., 2010). However, bulk milk SCC are more correlated with subclinical mastitis in dairy herds than with the incidence rate of clinical mastitis (IRCM; Valde et al., 2004; van den Borne et al., 2010). Also, farmers value the two manifestations differently (Huijps et al., 2008; Jansen et al., 2009). Hence, the effects of the Dutch national mastitis control program on the changes in farmers' motivation towards udder health and its improvement therein might differ between bulk milk SCC and IRCM, the latter not investigated yet.

The objective of this study was to quantify whether changes in dairy farmers' self-reported attitude, knowledge, and behavior towards udder health were associated with a decrease in IRCM in their herds.

Data for this study were obtained from two surveys that were initiated to evaluate the effectiveness of the Dutch mastitis control program (Jansen et al., 2009, 2010; Lam et al., 2013; van den Borne et al., 2010). In short, the first 1-year observational survey (defined as the 2004 survey) was conducted from July 1, 2004 to June 30, 2005 on 205 randomly selected Dutch dairy herds participating in the monthly dairy herd improvement program (van den Borne et al., 2010). The same herds that were still operative 5 years later were subsequently asked to participate in a second, identical survey from January 1, 2009 until December 31, 2009 (defined as the 2009 survey; Lam et al., 2013). Clinical mastitis data were prospectively collected by asking participating farmers to report all observed clinical mastitis (CM) cases in their herds during both surveys. The same

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questionnaire (Supplementary material Table S1) with items on farmers' attitude, knowledge, and behavior was sent to the participating farmers at the start of both surveys to obtain information on their motivation toward mastitis and the mastitis management implemented in their herds (Jansen et al., 2009, 2010). Monthly test day records (CRV, Arnhem, the Netherlands) from the participants in each survey were obtained to investigate the change in annual mean herd size, annual mean herd level milk yield, annual mean herd level parity and the farm's labor intensity (calculated as the annual mean herd size divided by the number of self-reported fulltime employees) on the change in IRCM.

The decrease in IRCM (expressed as the number of quarter CM cases per 100 cow-years at risk; van den Borne et al., 2010) between both surveys was determined by subtracting the 2009 value from the 2004 value. Gain scores for variables describing farmers' self-reported attitude, knowledge, and behavior were calculated by subtracting the 2004 value from the 2009 value (Jansen et al., 2010).

The effect of the 2004 IRCM, the changes in farmers' self-reported attitude, knowledge, and behavior, and the herd characteristics on the decrease in IRCM was quantified in several steps. In the first step, separate factor analyses were performed with gain scores that were coded on a 5-point Likert scale and with gain scores that were measured on a continuous scale in both surveys. The principal component method was used to extract initial factors from the offered gain scores. Gain factors with an eigenvalue >1 were retained for further analyses and an orthogonal (Varimax) rotation was used to simplify their interpretability. Absolute factor loadings ≥0.40 were used in the interpretation of rotated factors. The effect of selected gain factors and categorical gain scores on the decrease in herd level IRCM was evaluated in bivariable linear regression analyses in two subsequent and separate steps. Gain scores and gain factors with $P \leq 0.15$ in the Type 3 test were further tested in a combined multivariable linear regression analyses in the last step. A backwards selection procedure was performed in all linear regression analyses to identify the final regression model in which all gain scores or gain factors contributed significantly ($P \leq 0.05$). Two-way interactions between the 2004 IRCM and all significant gain scores and gain factors were evaluated to determine whether this relationship affected the decrease in IRCM. The 2004 IRCM was forced into each linear regression model because it was assumed that it would be easier to decrease IRCM from initially high IRCM levels compared with relatively low initial IRCM levels (Jansen et al., 2010).

Four models were built using the described procedure, analogous to our previous study (Jansen et al., 2009). The first model retained only the 2004 IRCM. The second model consisted of the 2004 IRCM and the significant farmers' attitude and knowledge gain scores and gain factors. The third model retained the 2004 IRCM and the significant gain scores and gain factors describing the herd characteristics and farmers' behavior. The gain scores and gain factors significantly contributing to the second and third models were further tested in the fourth multivariable linear regression model to quantify the between-herd variation in the decrease of IRCM for all gain scores and gain factors. The adjusted R^2 of each of these four models was determined to quantify their contribution to the between-herd variation in the decrease in IRCM.

Finally, two-sample *t*-tests and Wilcoxon signed-rank tests were conducted to evaluate differences in 2004 IRCM, 2004 herd characteristics and 2004 farmers' self-reported attitude, knowledge, and behavior between herds with complete datasets (2004 and 2009) and herds that participated in the 2004 survey only. Significance was set at $P < 0.01$ in these evaluation because of the large number of variables investigated (Supplementary material Table S1). Significance was defined at the $P \leq 0.05$ level in all other analyses. Statistical analyses were performed in SAS 9.2 (SAS Institute, Cary, NC, USA).

The median herd level IRCM decreased from 30.7 (mean: 34.9; range 2.5–89.6) in the 2004 survey to 29.0 (mean 31.7; range 3.3–88.1) cases per 100 cow-years at risk in 2009 ($P = 0.01$) in the 72 dairy herds that were included in the final regression models. The median decrease in herd level IRCM was 4.8 (mean: 3.2; range: –65.6–47.1) per 100 cow-years at risk. The other herds ($n = 133$) were excluded from the final statistical models because of 1 or more missing values in one of the two questionnaires. The 72 herds included in the final regression models did not form a group that was statistically different from the herds that participated in the 2004 survey in their 2004 IRCM ($P = 0.38$), annual mean herd size ($P = 0.61$), annual mean herd level milk yield ($P = 0.33$), average mean herd level parity ($P = 0.91$), or in their 2004 attitude, knowledge, or behavior, with one exception. Farmers included in the final regression models less frequently practiced forestripping in 2004 than farmers that only participated in the 2004 survey ($P = 0.004$).

Twenty-four attitude and knowledge gain factors and five attitude gain factors had an eigenvalue >1 and were further evaluated in linear regression models. Variables loading to gain factors significantly contributing to one of the linear regression models ($n = 4$) are displayed in Table 1. The 2004 IRCM explained 28% of the variance in the decrease in IRCM (Table 2). The IRCM decreased more markedly when it was at a higher level in 2004, as identified earlier for bulk milk SCC (Jansen et al., 2010).

Farmers' change in attitude and knowledge and farmers' change in behavior additionally explained 24% and 5% of the variance, respectively (Table 2; model 2 and 3). The final linear regression model in which the effect of the 2004 IRCM, the changes in farmers' self-reported attitude and knowledge and the changes in farmers' self-reported behavior on the decrease in IRCM were investigated, did not contain any items on the change in farmers' behavior (Table 2; model 4). This model was equal to the final model in which only items on farmers' changes in self-reported attitude and knowledge were investigated. No significant two-way interaction terms between the 2004 IRCM and gain scores and gain factors remaining in any of the final models were identified either. It was expected that a change in farmers' attitude and knowledge toward

Table 1
Sorted |factor loadings| ≥ 0.40 contributing to the final multivariable regression models for the decrease in IRCM.

Change of variable	Factor			
	1	2	3	4
Attitude and knowledge variables				
'I had many problems with mastitis the last 2 years'[a]	0.75			
'I generally don't have the mastitis situation on my farm under control'[a]	0.71			
'I regularly have contact with my veterinarian about mastitis'[a]	0.53			
Perceived knowledge about the milking process and mastitis[a]		0.81		
Perceived knowledge about the relationship between the milking machine and mastitis[a]		0.71		
Perceived knowledge about the housing of cows and mastitis[a]		0.58		
Worries about the costs of clinical mastitis[a]			0.66	
Perceived knowledge about the use of the results from the test day recording and mastitis[a]			0.57	
Worries about the costs of subclinical mastitis[a]			0.46	
Management and behavior variables				
Annual herd level mean parity[b]				0.87
Annual herd level mean milk production[b]				–0.54

[a] Coded on a Likert scale of 1 to 5 in both surveys.
[b] Normal distributed in both surveys.