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Farmer attitudes and motivation affect their health-seeking behavior in relation to mastitis in dairy cows—A survey on Swedish dairy farms with automatic milking systems

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ABSTRACT

Farmers play a key role in mastitis management, particularly in deciding whether and when to contact a veterinarian or initiate treatment. This cross-sectional study aimed to investigate how herd udder health status (measured as average herd SCC), relates to farmers' health-seeking behavior, and how this behavior is influenced by farmers' herd-level udder health perception, perceived control, motivational values, and production system (organic vs. conventional). A survey was distributed to 697 Swedish dairy farmers using automatic milking systems, with 244 complete responses and 164 included in the final analysis. Farmers were presented with 3 mastitis scenarios and categorized into 4 groups based on their treatment intentions. With the self-regulation model of illness as a theoretical framework, we applied a serial multiple mediator model to explore the relationships between objective herd health, psychological constructs, and treatment behavior. Results showed that average herd SCC was not directly associated with farmers' treatment decisions. Instead, herd-level udder health perception, perceived control, and both economic and noneconomic motivation significantly influenced health-seeking behavior. Among organic farmers, perceived control and economic values had a direct effect, although no significant pathway was found among conventional farmers. These findings highlight the importance of addressing farmers' subjective perceptions and motivations in advisory strategies to improve mastitis management and animal welfare outcomes.
Key words: udder health, health-seeking behavior, dairy cattle, organic farming

INTRODUCTION

Mastitis in dairy cows is the most common infectious disease in the dairy sector, in both organic and conventional production systems, causing severe pain in the udder of the cow, and it is the most common reason for antibiotic use in dairy production (Swinkels et al., 2015; Jamali et al., 2018; Lardé et al., 2021). The usage of antibiotics increases the risk for antibiotic resistance and thus constitutes a public health concern. In addition, mastitis is the most expensive cow health disorder, due to veterinary treatment costs, increased culling risk, withdrawal of milk, price penalties for milk delivered to the processor, and increased workload (Hogeveen et al., 2019).

Although more common during the first weeks after parturition, mastitis can occur at any point in time. Farmers need to work continuously and proactively to control the prevalence on their farm and prevent future cases (Cobirka et al., 2020; Shock et al., 2020; Stanek et al., 2024). Several studies suggest that the implementation of management practices to reduce mastitis likely depends on human factors, including the farmer's beliefs and attitudes toward mastitis treatment and prevention (Vaarst et al., 2002; Jansen et al., 2009; Lind et al., 2023). Farmers' motivation to engage in preventive measures and improve mastitis control appears to be primarily driven by their perception of the economic losses associated with mastitis (Valeeva et al., 2007; Huijps et al., 2010). This aligns with the view that the farmer–dairy cow relationship is largely utilitarian in nature (Bock et al., 2007). However, more recent research show that farmers are equally motivated by values not solely related to economic outcome, such as taking pleasure in having healthy cows (Valeeva et al., 2007; Hansson and Lagerkvist, 2014a,b).

Although recent research has focused on adherence to veterinary advice (Persson Waller et al., 2021; Svensson et al., 2019), the farmer's initial decision to contact a veterinarian or initiate treatment when a

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cow has an udder health problem—an example of their health-seeking behavior—have received less attention. Deciding which animals to treat, and when, are important parts of farmers' mastitis management, as early diagnosis and treatment are key factors for a successful treatment outcome (Milner et al., 1997; Hogeveen et al., 2021). In Sweden, initiation of mastitis treatment is usually performed by a veterinarian, unless the farm has a specific agreement with a herd-health veterinarian. However, the farmer acts as a gatekeeper for when a veterinarian is contacted and is thus, in the majority of cases, the one who makes the decision. Decision making in critical circumstances involves complex, often conflicting factors that must be weighed against each other to reach a decision (Hansson and Lagerkvist, 2014b; Lind et al., 2020; de Jong et al., 2024). Farmers' health-seeking behavior, in terms of contacting a veterinarian or initiating treatment when a cow is afflicted by udder health problems, can be seen as an example of decision making in critical circumstances.

In the specific case of mastitis management, farmers' choices on whether and when to treat mastitis are shaped by their views on disease severity, timing within lactation cycle, and seasonal influences (Vaarst et al., 2002; de Jong et al., 2024). Motives for initiating a veterinary contact include achieving a quick recovery for the cow, preventing the cow from becoming 3-teated, preventing reduced milk yield and maintain a healthy herd, whereas the potential cost was not seen as a concern by farmers (Espetvedt et al., 2013). In addition, production system—conventional or organic—have been suggested to be associated with farmers' attitudes in relation to animal welfare (Hubbard et al., 2007; Kling-Eveillard et al., 2007), animal health strategies, and mastitis treatment (Duval et al., 2017).

Factors influencing farmers' decision making and health-seeking behavior are clearly complex. By extending our understanding of these factors, we can gain valuable insights, which in the long term can improve recommendations and advisory services and enhance animal welfare outcomes. The objectives of this study were to examine how a herd's udder health status (here defined as the average herd somatic cell count [**AHSCC**]), was related to farmers' health-seeking behavior (represented by when a farmer decides to contact a veterinarian or initiate a treatment), as well as how the health-seeking behavior was associated with farmer attitudes, motivation, and farm characteristics, with special focus on production system—conventional or organic. We hypothesized that a more active approach to seeking veterinary advice or initiating treatment could be associated with a better udder health status in the herd, and thus a lower AHSCC.

MATERIALS AND METHODS

Conceptual Framework

Human perception of illness and subsequent coping behavior are believed to be crucial aspects when managing disease both in humans (Dempster et al., 2015) and in animals (Jansen, 2010; Lind et al., 2023). We used the self-regulation model of illness (Leventhal, 1984; Leventhal et al., 2001; Cameron and Leventhal, 2003), also known as the common-sense model, as a theoretical framework in this study. The self-regulation model of illness suggests that an individual's perception and emotional experience of symptoms when facing a disease guides their understanding of the cause and controllability. In human medicine, illness perception has been found to correlate more strongly with health outcomes than with actual disease severity (Aalto et al., 2006; Petrie et al., 2007; Sawyer et al., 2019). In mastitis management, it can be assumed that farmers' understanding of mastitis as a production disease in their own herd (i.e., their illness perception; henceforth referred to as herd level udder health perception), combined with the tools and knowledge they have available, affects if and how they perceive that they can control or treat it (Vaarst et al., 2002; Jansen, 2010; Lind et al., 2023). We expected that farmers' perceptions of their herd-level udder health influence their approach to animal health management, including when they decide to contact a veterinarian or initiate treatment, thus affecting their health-seeking behavior. Although the concept can be related to preventive measures, for example, we decided to use the intention of treating a cow with an ongoing udder health problem as a proxy for health-seeking behavior. Decisions regarding mastitis treatment sets a concrete example that was feasible to use in a survey, and it reflects situations commonly experienced in dairy farms in Sweden.

In addition, we extended the conceptual framework by including insights from previous findings of farmer motivation in terms of animal welfare (Hansson and Lagerkvist, 2016; Hansson et al., 2018). Farmers' motivation to work with animal welfare issues is driven by a combination of economic and noneconomic motivational values (also referred to as use and nonuse values; Hansson and Lagerkvist, 2016). Economic motivational values are related to economic benefits derived from implementing animal welfare measures, aligning them with business goals, whereas noneconomic motivational values refer to the benefits obtained from good animal welfare, regardless of economic outcome (e.g., the benefit of taking pleasure in having healthy animals; McInerney, 2004; Lagerkvist et al., 2011; Lusk and Norwood, 2012). It is likely that both types of motivation also influence farmers' health-seeking behavior in relation to if and when the farmer perceives it necessary to contact a veterinarian or initiate a mastitis treatment.

To investigate this, we applied a serial multiple mediator framework to study whether the current udder health status on the own farm, represented by the AHSCC, was associated with farmers' health-seeking behavior (here defined as when in time they considered it necessary to initiate treatment or contact a veterinarian). Farmers' herd-level udder health perception, their perceived control over the situation and motivation to work with animal health and welfare (in terms of economic and noneconomic motivation) were included as mediators in the model.

Survey Development and Scenarios

A survey was developed during October 2020 to January 2021. The development process involved an expert on survey design and 2 test runs on 3 independent farmers. Questions that were unclear or deemed redundant were changed or removed during the process. The final survey consisted of 4 different parts, related to (1) respondent and herd characteristics, (2) attitudes toward udder health issues, (3) farmer behavior, and (4) motivation for working with udder health. The full survey is available from the authors upon reasonable request.

Parts 2 and 4 were constructed as statements where respondents could agree or disagree, rated on a Likert scale ranging from 1 to 5, allowing respondents to express their level of agreement. These statements were designed to assess their attitudes and motivation related to udder health and mastitis in specific and were later included in the latent variables representing herd udder health perception, perceived control and economic and noneconomic motivation. We used statements that had been validated in previous studies on attitudes and motivation in relation to udder health and animal welfare, with some modifications to fit the context of this study. In part 2, we used statements such as: "The udder health in the herd is good" (Kayitsinga et al., 2017; Lind et al., 2025) to assess farmers' herd-level udder health perception. To assess perceived control, we used statements such as: "We have good control over udder health in the herd" (Lind et al., 2025). Part 4 focused on motivational values, with statements designed to capture both economic and noneconomic motivations as found in previous studies (Hansson and Lagerkvist, 2016). For economic values, statements addressed practical and economic concerns, for example: "To ensure that the cows' production is at a level that makes the company as profitable as possible." For noneconomic values, we included welfare-oriented statements such as: "Ensuring that cows with mastitis receive prompt diagnosis and treatment so that the cow does not have to suffer." We further extended the concept of noneconomic motivation to also include environmental concerns, incorporating items inspired by Röös et al. (2023), such as: "Having healthy cows contributes to low greenhouse gas emissions." All items used in the present study are listed in Table 1.

In part 3, concerning farmer behavior, 3 different mastitis scenarios were presented to the respondents, described with symptoms and cow characteristics: (1) A primiparous cow with acute severe clinical mastitis (**ASCM**) with fever and anorexia, 8 DIM; (2) an older cow with high SCC and no clinical symptoms (subclinical mastitis), late in lactation; and (3) an older cow with a recurrent case of moderate clinical mastitis (**RMCM**). The scenarios were developed to represent different udder health problems that are commonly encountered on dairy farms, with different grades of severity. They were used to explore farmers' strategies on when to contact a veterinarian or initiate a mastitis treatment, to be able to differentiate behavior among different respondents and thus used as an indicator of farmers' health-seeking behavior. The farmers were asked to state if, and when in time, they most likely would contact a veterinarian, or initiate treatment (if they had approval to do that through a contract with their herd veterinarian), based on the description of each case. The response alternatives were to (1) contact a veterinarian (or initiate treatment) **i**mmediately, (2) contact a veterinarian (or initiate treatment) in a few days if the cow doesn't recover by herself, (3) not contact a veterinarian at all, and (4) other decision (specified in free text). Based on the responses, 2 of the authors (1 veterinarian and 1 psychology researcher), coded the respondents into an aggregated grouped variable. Based on their responses, the respondents were categorized into 4 groups: health-seeking behavior (**HSB**) 1 to 4, ranging from the most respondents with the most active (HSB 1) to more passive (HSB 2–4) health-seeking behavior. The categorization was partly dependent on what was considered as an appropriate decision for each scenario, based on described symptoms in the scenario and current Swedish mastitis treatment guidelines (The Swedish Veterinary Association, 2016). The recommendation would be to immediately contact a veterinarian for case 1 (ASCM), whereas for case 2, the recommendation would be to induce dry-cow treatment at dry-off and not treat the cow before drying off. Case 3 would, in most cases, be suitable for treatment, but as the cow did not express any general symptoms (such as fever or anorexia), waiting a few days or choosing not to treat the cow medically could also be reasonable depending on the specific situation.

To be categorized as HSB 1 (the most active health-seeking behavior), respondents had to answer that they would contact a veterinarian (or treat) both case 1 and

Table 1. Descriptive statistics of the items used as mediators in the serial multiple mediator (SMM) model[1]

Variable	Item	Organic farms (n = 48)	Conventional farms (n = 116)	All (n = 164)
M1: Herd level udder health perception				
2A	The udder health in the herd is good.	3.71 (0.849)	3.76 (0.900)	3.74 (0.884)
2B	The herd has low cell count.	3.37 (1.044)	3.36 (1.016)	3.37 (1.021)
2C	The herd has a lower cell count than most other herds.	3.42 (1.711)	3.47 (1.634)	3.46 (1.652)
2F	We are actively working to improve udder health.	4.10 (0.881)	4.08 (0.746)	4.09 (0.854)
2D	The herd has fewer cases of clinical mastitis than most other herds.	3.92 (1.609)	4.05 (1.636)	4.01 (1.624)
M2: Perceived control of situation and routines				
2K	We have good procedures for identifying cows with poor udder health.	4.06 (0.810)	3.97 (0.796)	4.00 (0.799)
2J	We have good knowledge of which bacteria cause mastitis in the herd.	3.94 (0.998)	3.78 (1.031)	3.82 (1.021)
2I	We have good control of the udder health at the herd.	3.88 (0.761)	3.93 (0.821)	3.91 (0.802)
M3: Noneconomic values				
4J	Having healthy cows contributes to high consumer confidence in Swedish milk production.	4.50 (0.744)	4.55 (0.762)	4.54 (0.754)
4F	To ensure that cows with mastitis receive a prompt diagnosis and treatment so that the cow does not have to suffer.	4.56 (0.580)	4.52 (0.728)	4.53 (0.687)
4H	Having healthy cows contributes to low antibiotic use in Sweden.	4.71 (0.544)	4.77 (0.549)	4.75 (0.547)
4I	Having healthy cows contributes to low emissions of greenhouse gases.	3.98 (1.211)	3.84 (1.497)	3.88 (1.418)
4G	Having healthy cows that contribute to resource-efficient Swedish food production.	4.48 (0.799)	4.64 (0.727)	4.59 (0.750)
M4: Economic values				
4B	To ensure that the cows stay healthy to avoid financial losses.	4.54 (0.617)	4.79 (0.485)	4.72 (0.538)
4A	To ensure that the cows' production is at such a level that the company becomes as profitable as possible.	4.50 (0.715)	4.68 (0.584)	4.63 (0.628)
4C	Ensuring that the cows stay healthy so that I have time for other things.	4.21 (1.031)	4.35 (0.962)	4.31 (0.982)
4E	To ensure that cows with mastitis receive a prompt diagnosis and treatment so that the cow quickly returns to production.	4.31 (0.776)	4.50 (0.716)	4.45 (0.737)

[1]Respondents were asked to rank the items on a Likert-scale of 1 to 5, where 1 = low agreement and 5 = high agreement. Values represent the mean for each question and the SD in brackets. The values are presented for all farmers and separated into organic and conventional farmers. Number indicates the section of the questionnaire in which item belongs, and the letter indicates the unique question in the questionnaire.

case 3 immediately. For HSB 2, respondents had to respond that they would contact a veterinarian (or treat) case 1 immediately, whereas their response to case 3 could be to contact a veterinarian (or treat) in a few days, or not at all. To be categorized as HSB 3, respondents had to answer that they would contact a veterinarian (or treat) case 1 within a few days. Their response to case 3 did not affect this allocation. For HSB 4 (the most passive health-seeking behavior), the response to case 1 had to be to not call the veterinarian (or treat the cow) at all. Their response to case 3 did not affect this allocation. The response to case 2 did not affect any of the allocations, as this was a subclinical case where no immediate measures are recommended according to national guidelines.

The HSB groups were then used as the outcome in the analysis (Y in the model). In addition, respondents were asked about other management decisions around the cows in the scenarios (e.g., move to sick pen, alternative treatments, culling, and so on).

If respondents gave consent, additional herd data were obtained from the Swedish Official Milk Recording Scheme (**SOMRS**). The data were based on cow-level DHI test-day information on SCC, and transformed into a herd-level variable by calculating the arithmetic mean for each herd. Thus, the results are based on all lactating cows on the farm, in comparison to the bulk milk SCC measured in milk delivered to the dairy plant, in which milk from cows with high SCC may have been separated.

Study Population and Data Collection

The survey was distributed in February 2021 via Netigate (Netigate AB, Stockholm, Sweden). To determine the minimum number of subjects required for adequate study power, we performed a sample-size estimation based on the total population of active Swedish dairy farmers registered using automated milking systems (**AMS**; data provided by SOMRS) in 2020 (n = 709).

The estimation was conducted using a 95% CI and a 5% margin of error, resulting in a required sample size of at least 228 participants to draw statistically valid conclusions from the questionnaire. The sample size was calculated to ensure that we collected enough observations to make valid inferences about the population. The calculation was based on the confidence interval equation, where the margin of error (ε) represents the maximum acceptable deviation from the true population value. By rearranging the equation to solve for sample size (n), we determined the required number of participants. Additionally, according to the central limit theorem, the sampling distribution of the mean follows a normal distribution when the sample size is sufficiently large ($n \geq 30$). As our estimated sample size ($n = 228$) exceeded this threshold, we assumed a normal distribution of sample means, allowing for reliable statistical inferences. Based on experiences on response rates from previous similar studies (Lind et al., 2023, 2020), we decided to send the invitation by e-mail to all farmers that met the inclusion criteria (i.e., affiliation to the SOMRS and AMS registered as the primary milking system on the farm; n = 709). E-mail addresses were obtained from the SOMRS. Distribution reached 697 e-mail addresses. Reasons for not reaching all 709 were that some addresses had previously "opted-out" from Netigate surveys (n = 11) and nonfunctioning e-mail address (n = 1). The survey was open for 4 wk after distribution, with 3 reminders sent out to nonresponders during that time. The person responsible for the udder health in the herd was asked to fill in the survey. Additional data, including herd level milk yield and herd level milk SCC, based on DHI test milkings were obtained from the SOMRS if the respondent gave consent to this in the survey and provided their herd ID. In total, we received 246 responses, with 244 participants completing all 3 mastitis scenarios, yielding an effective response rate of 35%.

Data Screening and Preparation

The responses from the questionnaire were exported from Netigate to Microsoft Excel 2007 (Microsoft Corporation) for initial data cleaning. Obvious inaccurate answers were corrected or changed to missing (e.g., birth year given as age). In addition, if free-text answers to the mastitis scenarios indicated that the cow would receive treatment according to one of the response alternatives, they were re-categorized.

Before statistical analysis, data were screened for missing values in the variables used as mediators. Out of the 244 farmers who filled in all 3 scenarios, 164 farmers were included in the final analysis. The notable reduction in participating farmers occurred as the statistical models required complete data across all key variables (M1–M4, X, and Y). Respondents with missing values on any of these indicators were excluded, which explains the drop in sample size. Available information (e.g., herd size and other herd characteristics) did not differ between the final sample size and all respondents in the survey, indicating that the dropout was more likely related to the burden of answering the full questionnaire rather than to underlying differences in key characteristics of the respondents.

Statistical Analysis

Farmers' responses to the different mastitis scenarios were described, and Pearson chi-square tests were used to make a simple statistical comparison between conventional and organic herds in terms of how fast they would contact a veterinarian and which other measures they would likely perform for each mastitis case. A Pearson chi-square test was also used to examine the relationship between production type and farmers' health-seeking behavior across all 4 categories (HSB 1–4).

The main analysis was performed in 2 steps. First, exploratory factor analysis (**EFA**) was used to reduce the total number of potential explanatory variables into 4 latent variables (further described below) representing herd-level udder health perception, perceived control, and noneconomic and economic motivation, based on responses to the statements in the questionnaire.

In the second step, a serial multiple mediator (**SMM**) model was constructed, with AHSCC as independent variable and HSB group as outcome. To meet the criteria for the SMM model, which only allows for continuous or binary dependent variables, the outcome was recategorized into a binary variable (HSB 1 vs. all other groups, based on response distribution as there were few respondents in HSB 3 and 4, see Table 2). The latent variables from the EFA were included as mediators in the model (Figure 1). Multicollinearity diagnostics indicated no concerns, as variance inflation factor values when analyzing all relationships between X, M1, M2, M3, and M4 ranged from 1.09 to 1.57, and tolerance values were all well above 0.20, suggesting no problematic multicollinearity. The EFA and SMM are described in detail below.

Exploratory Factor Analysis

Using EFA enabled the reduction of the questionnaire data into latent variables (representing the mediators used in the analysis), while also confirming which variables should be included in the analyses. The items in parts 2 and 4 of the survey were constructed to measure herd-level udder health perception, perceived control and economic and noneconomic motivation. An EFA was used to ensure that each of the variables theoretically related to each other in our proposed model, and

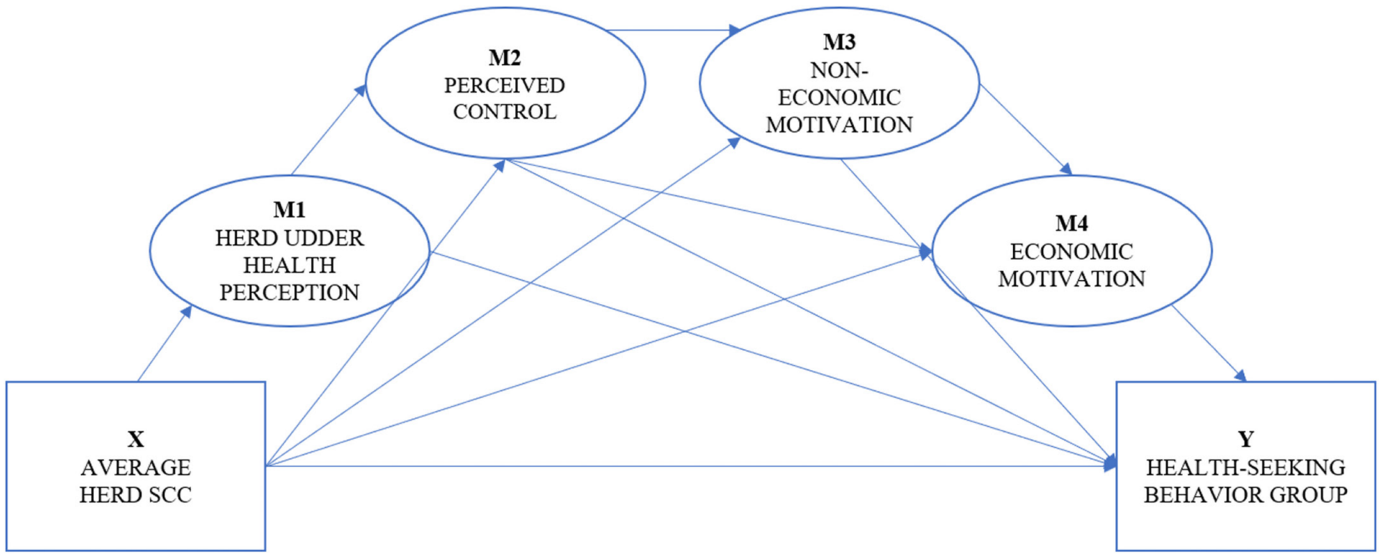

Figure 1. Conceptual diagram of multiple mediation model 6 (Preacher and Hayes, 2008). For the present study, we used the average herd SCC on the farm as X. The mediating factors were M1: Farmers' perception of if they perceived the herd level udder health on the farm as good; M2: Farmers' perceived control of the situation; M3: Noneconomic motivational values related to animal health and welfare; and M4: Economic motivational values related to the economic output on the farm based on animal health and welfare. The outcome of interest (Y) was health-seeking behavior, represented by farmers' decisions on when to contact a veterinarian or initiate treatment for 3 fictive mastitis scenarios.

thus loaded onto the same factor. The EFA allowed us to examine the underlying structure by analyzing the covariation among all items (Table 1). This approach enabled us to assess whether the statements grouped together as expected, both theoretically and statistically. The analysis resulted in 4 latent variables (M1–M4) that were included in the SMM model.

Herd-Level Udder Health Perception. The latent variable used as M1 expresses farmers' perception of the udder health status on their farm. It was included as it was considered to be an important aspect in shaping the farmer's perception of the situation and considered a major driver of their treatment decision.

Perceived Control of Situation and Routines. The latent variable used as M2 expresses farmers' perceived control over the mastitis situation on the own farm and their perceived control over their own routines. Included aspects cover dairy farmers' feelings of confidence about being able to prevent mastitis, reduce incidence of mastitis, and control the situation on the farm.

Noneconomic Motivation. The latent variable used as M3 covered aspects of farmers' motivation to work with animal welfare issues, where noneconomic values refer to the benefits obtained from good animal welfare regardless of economic outcome.

Economic Motivation. The latent variable used as M4 covered aspects of farmers' motivation to work with animal welfare issues related to economic benefits derived from implementing animal welfare measures, aligning them with business goals.

The EFA was performed until we arrived at a clean pattern matrix showing good adequacy (i.e., until the variables loaded on separate variables). All factor loadings are presented in Table 3. All items had a loading amplitude of at least 0.4. Reliability analysis for all 4 latent variables identified in the EFA had a Cronbach α ranging from 0.652 to 0.714, which is considered an acceptable level (Taber, 2018). To allow for correlation between the factors Promax rotation was used. After retrieving a clean pattern matrix, the items loading to each of the latent variables were created.

SMM Analysis

An SMM allows multiple mediators to be examined and reports the individual effects of each mediator while controlling for the others, meaning any significant ($P < 0.05$) mediation effects are unique. Multiple mediator analysis (Hayes and Rockwood, 2017) has been used in previous studies in psychology (Pot-Kolder et al., 2018), epidemiology (Zhao et al., 2018), and economics (Onubi and Hassan, 2020), and most recently to explore the relationship between human and animal health in terms of mastitis (Lind et al., 2025), but it has not, to our knowledge, been used to understand farmers' health-seeking behavior in mastitis management.

Our SMM model is visualized in Figure 1, and it consisted of an independent variable (herd udder health status, measured as AHSCC), and a dependent variable (farmers' health-seeking behavior regarding contacting a

Table 2. Cross-tabulation of respondents divided into 4 (HSB 1, 2, 3, and 4) or 2 (HSB 1 vs. HSB 2–4) groups based on their health-seeking behavior[1] in a survey targeting Swedish dairy farmers with automatic milking systems, divided by production system

	Health-seeking behavior group				Binary HSB variable		
Item	HSB 1	HSB 2	HSB 3	HSB 4	HSB 1	HSB 2–4	Total
Conventional farms (n)	63	32	15	6	63	53	116
Mean SCC (cells/mL)	225,000	242,000	255,000	241,000	225,000	246,000	234,000
Organic farms (n)	16	26	3	3	16	32	48
Mean SCC (cells/mL)	254,000	255,000	239,000	257,000	254,000	254,000	254,000
Total	79	58	18	9	79	85	164
Mean SCC (cells/mL)	231,000	248,000	252,000	246,000	231,000	249,000	240,000

[1]Assessed by the point in time that farmers reported they would contact a veterinarian or initiate mastitis treatment for 3 different mastitis scenarios.

veterinarian or initiating treatment [HSB group]). The 4 latent variables (M1–M4) from the EFA were included as mediating factors. The causal sequence from M1 to M4 was based on both previous studies and our theoretical conceptualization of how illness perception develops and influences behavior. According to the self-regulatory model of illness, individuals must first form an understanding of a disease to know how to manage it. For this reason, we positioned M1 (perception of udder health) at the start of the sequence. Building on this, farmers' beliefs about their ability to handle the situation are represented by M2, which logically follows perceptions of the problem. Studies by Hansson and Lagerkvist (2016), among others, have demonstrated that farmers' motivation to engage in mastitis and udder health management is often driven more by noneconomic values than by economic values. We therefore placed these relational aspects later in the sequence (M3). Finally, the role of economic or utilitarian values was positioned as the last mediator (M4), reflecting how farmers also consider livestock as part of the business enterprise, where productivity and profitability are essential. By arranging the mediators in this order, the model tests both the sequential process and the unique contribution of each mediator.

The SMM analysis was performed using SPSS version 26 (SPSS Statistics for Windows, IBM Corp., version 26.0, Armonk, NY) using the PROCESS macro version 4.3 (Hayes, 2017; Hayes and Preacher, 2013; Hayes and Rockwood, 2017). The PROCESS macro provides preset models that can be used in SPSS for which mediation and moderation can be tested, and that allows for the estimation of the effect of multiple mediators in a causal chain. For the current analysis, we adopted the macro referred to as "model 6," a model that tests the relationship between Y and X, while taking into consideration the effect of multiple mediators (see conceptual diagram in Figure 1). For the analysis, the macro used the setting 5,000 bootstraps with confidence level of 95%. Although PROCESS defaults to linear regression for continuous dependent variables, it automatically applies logistic regression when the dependent variable is dichotomous. Thus, direct and indirect effects were still estimated, but expressed in log-odds/odds ratios rather than raw regression coefficients.

For the macro, the mediators, M1 to M4, were arranged in a causal sequence, such that M1 is before M2, M2 is before M3, and so on. This allowed for simultaneous estimation of the separate effects of each relationship between X on M1.... X on M4, X on Y, M1 on M2.... M1 on M4, M1 on Y.... M4 on Y, see Figure 1 for all tested relationships (Hayes and Rockwood 2017). The method links the mediators with a specified direction of causal flow, leading to the creation of paths between mediators, as shown in Figure 1, to be able to see how they would affect each other. The SMM allows for a test of the combined effects of all proposed mediators (here referred to M1, M2, M3, and M4) to be carried out (i.e., the total indirect effect). We ran 3 different models with the same setup. First, we analyzed the full sample of farmers, both without and including covariates. Next, we conducted separate analyses for organic and conventional farmers to explore potential differences between the 2 production types.

In the final model including all responses, we accounted for the covariates production system (organic or conventional) and herd size (using number of AMS units as a proxy). In the separate models for organic and conventional farms, we accounted for herd size.

Ethical Statement

In agreement with the Swedish Ethical Authority, and in consultation with the ethics and legal department at the Swedish University of Agricultural Sciences university, the study did not require an ethical permit according to Swedish law (SFS 2003:460; Swedish Parliament, 2003). Nevertheless, a strict code of conduct as set out by the Swedish Research Council (Swedish Research Council, 2024) was followed, including gaining informed consent from the participants and guaranteeing the pseudonymisation of their responses and herd registry data. No sensitive personal information was collected for the study.

Table 3. Factors, extracted using the exploratory factor analysis with maximum likelihood and Promax rotation, constituting latent variables representing items in the questionnaire; 164 farmers were included in the analysis

	M1	M2	M3	M4
Item[1]	Udder health perception (α = 0.714)	Perceived control (α = 0.652)	Noneconomic values (α = 0.689)	Economic values (α = 0.698)
2A	0.803			
2B	0.795			
2C	0.600			
2F	0.464			
2D	0.437			
2K		0.897		
2J		0.502		
2I		0.422		
4J			0.723	
4F			0.643	
4H			0.630	
4I			0.605	
4G			0.473	
4B				0.907
4A				0.687
4C				0.455
4E				0.439
Eigenvalue	4.116	1.374	2.619	1.502
% of total variance	24.211	8.079	15.404	8.833

[1]Individual questions included in the questionnaire; each variable is presented in Table 1. Number indicates the section of the questionnaire in which the item belongs, and the letter indicates the unique question in the questionnaire.

The farmers were not given any financial incentive in exchange for their participation.

RESULTS

After data screening and exclusion of cases that did not fulfill all necessary parts for the present study, we ended with a sample of 164 farmers. The respondent population was similar to the national population of dairy farms in terms of herd size (108 vs. 102 [mean national herd size for 2021]), milk yield (just over 11.000 kg in both respondent and national population [affiliated to the SOMRS]), bulk tank SCC (around 240,000–250,000 cells/mL) and breed (around 50% Swedish Holstein and around 25% Swedish Red). The proportion of organic herds was larger in the respondent population (29%) compared with the national proportion of organic dairy producers in 2021 (18%).

The behavior related to case 1 (acute clinical mastitis), did not differ between organic and conventional herds, whereas a higher proportion of conventional herds responded that they would contact a veterinarian for case 2 ($P < 0.01$) and case 3 ($P < 0.03$) compared with organic herds (Figure 2). A higher proportion of organic herds responded that they would cull the cow in case 2 and 3 compared with conventional herds (Figure 3). The distribution of organic and conventional respondents in the different HSB groups, as well as the groups' mean AHSCC are presented in Table 2. Conventional farmers were more likely to belong to HSB 1, whereas organic farmers were more common in HSB 2 ($P = 0.01$). There were few respondents in HSB group 3 and 4 (n = 18 and 9, respectively). The same difference between organic and conventional herds were seen when comparing the binary variable of HSB 1 and HSB 2 to 4 ($P = 0.014$), with a higher proportion of conventional respondents in HSB 1, representing the most active health-seeking behavior.

Figures 4 and 5 and Tables 4 and 5 show the results of the SMM analysis, both for all farmers and separately for production type. Although AHSCC was not directly associated with HSB group ($P = 0.411$), the SMM model for all farmers proposed that AHSCC indirectly influences farmers' health-seeking behavior through multiple mediators. First, we found a negative association between AHSCC and M1, indicating that a lower AHSCC was associated with a more positive perception of the herd health situation ($P < 0.001$). The herd health perception was, in turn, positively associated with M2—farmers' perceived control ($P < 0.001$)—meaning that farmers who perceived the udder health on their farm as good felt that they had more control over the situation. In the next step of the analysis, it was seen that M2 was positively associated with both M3 (noneconomic motivation) and M4 (economic motivation; $P < 0.01$ and $P < 0.001$, respectively). Among the predictors, M4 (economic motivation) was the only variable directly associated with HSB group ($P < 0.01$), where farmers that ranked the economic motivational values as more important were

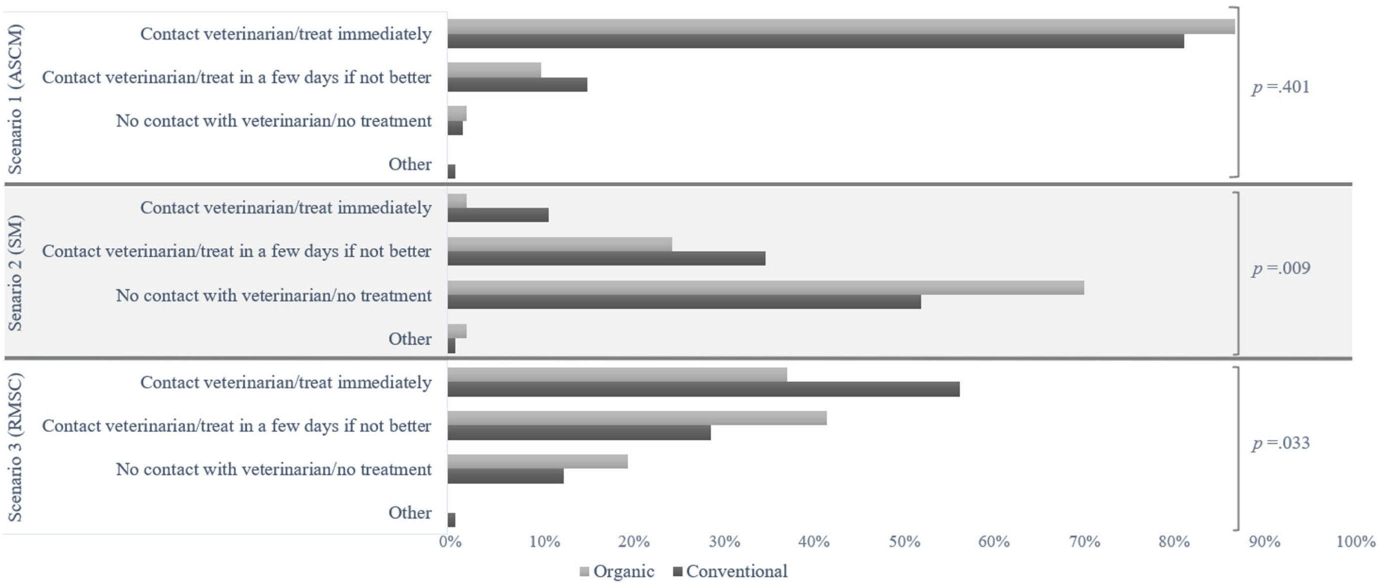

Figure 2. Response distribution on how organic (n = 48) and conventional (n = 116) farmers reported whether and when they would contact a veterinarian or initiate treatment in 3 fictive mastitis scenarios: (1) A primiparous cow with acute severe clinical mastitis (ASCM); (2) an older cow with high SCC and no clinical symptoms (subclinical mastitis, SM); and (3) an older cow with a recurrent case of moderate clinical mastitis (RMCM).

more likely to be in the HSB 1 group (and thus more active in terms of contacting a veterinarian or initiating treatment). A 1-unit increase in M4 was associated with a ~3-fold increase in the odds of the outcome HSB 1, holding all other variables constant.

The final model including all variables revealed that the overall model was significant, $\chi^2(5) = 16.38$, $P = 0.006$, with Nagelkerke $R^2 = 0.13$. When covariates were added to the model (production type and number of robots), model fit improved, whereas the sequential mediation pathway from X → M1 → M2 → M3 → M4 → Y remained significant ($P < 0.05$). In addition to M4 being a significant predictor, the covariate for production type (organic vs. conventional) also emerged as a significant negative predictor ($P < 0.05$). This means that even after accounting for the mediation chain, organic production type uniquely reduced the odds of being in the HSB 1 group, and M4 continued to be the primary mediator associated with higher odds of the outcome (see Table 4).

To further explore the effect of production type, analyses were conducted separately for organic and conventional farms (see Table 5). For organic farms only, the final model including all variables was marginally significant when evaluated against a threshold of $P < 0.07$, $\chi^2(5) = 10.74$, $P = 0.057$. The model showed a similar significant flow, X → M1 → M2 → M3 → M4 → Y, in the same way as in the model including all farmers (see Figure 4 and 5). The model accounted for ~28% of the variance in the outcome (Nagelkerke $R^2 = 0.279$), suggesting a moderate effect.

For conventional farms only, the final model was also marginally significant at the $P < 0.07$ threshold, $\chi^2(5) = 10.41$, $P = 0.064$, explaining about 12% of the variance in the outcome (Nagelkerke $R^2 = 0.115$). Although this suggests that the predictors provide some explanatory power, the effect is modest and results should be interpreted with caution. In addition, no significant flow from X → M1 → M2 → M3 → M4 → Y, was found, as there was no significant linkage to the final outcome.

Overall, the model for organic farms explained more than twice as much variance in the outcome ($R^2 = 0.279$ vs. 0.115), suggesting that the predictors may be more relevant for explaining variation among organic farms than conventional farms. However, in both cases, caution is warranted given the marginal significance levels. See Table 5 and Figure 5 for detailed results.

DISCUSSION

Our findings highlight the complexity of farmers' health-seeking behavior in mastitis management in farms with AMS, regarding when to contact a veterinarian or initiate a treatment when a cow has an udder health problem. The hypothesis that a more active health-seeking behavior would be associated with a lower AHSCC could not be validated through our results. However, a limitation of the initial hypothesis was that our cross-sectional study design has no possibility to evaluate causality; it might also be true that a high AHSCC results in a more active health-seeking behavior as an attempt to take

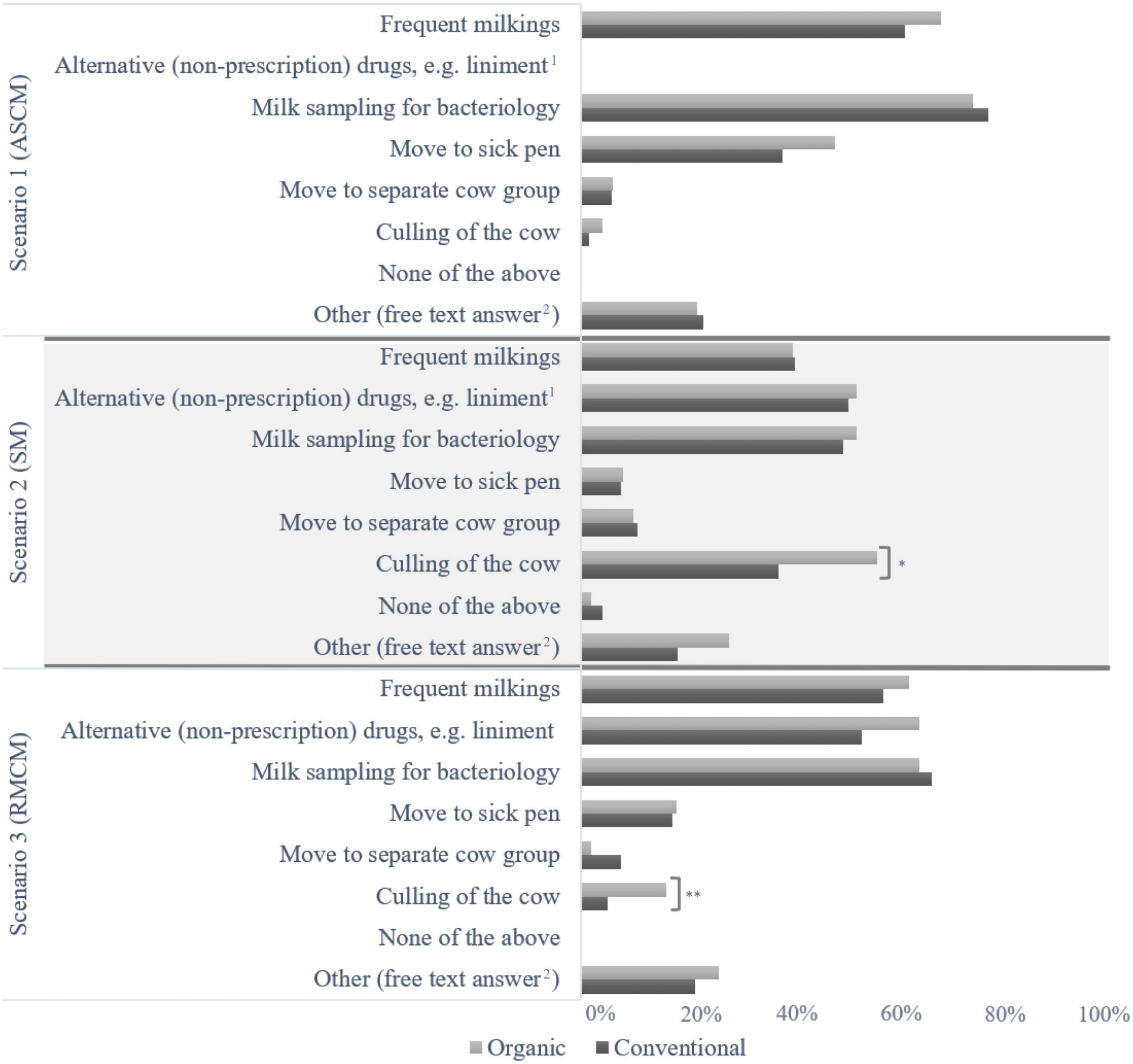

Figure 3. Response distribution on how organic (n = 48) and conventional (n = 116) farmers thought they would decide about management for cows with different udder health problems according to 3 mastitis scenarios: (1) A primiparous cow with acute severe clinical mastitis (ASCM); (2) an older cow with high SCC and no clinical symptoms (subclinical mastitis, SM); and (3) an older cow with a recurrent case of moderate clinical mastitis (RMCM). Significance noted by $*P < 0.05$, $**P < 0.01$. No associations were significant at the level of $P < 0.001$. [1]This alternative was missing for scenario 1 due to an error in the survey (was added in several free text responses for scenario 1). [2]Free text answers mainly related to drying off one teat.

control over the situation. However, we did find that subjective factors, such as herd udder health perception, perceived control, and motivational values (both economic and noneconomic), emerged as key mediators for health-seeking behavior. These findings align with the self-regulation model of illness (Leventhal et al., 2001), which posits that individuals' perceptions and emotional responses to illness guide their coping behavior more than objective indicators. Our results are consistent with previous studies showing that herd udder health perception and perceived control are critical in shaping health-related decisions in dairy farms (Kayitsinga et al., 2017;

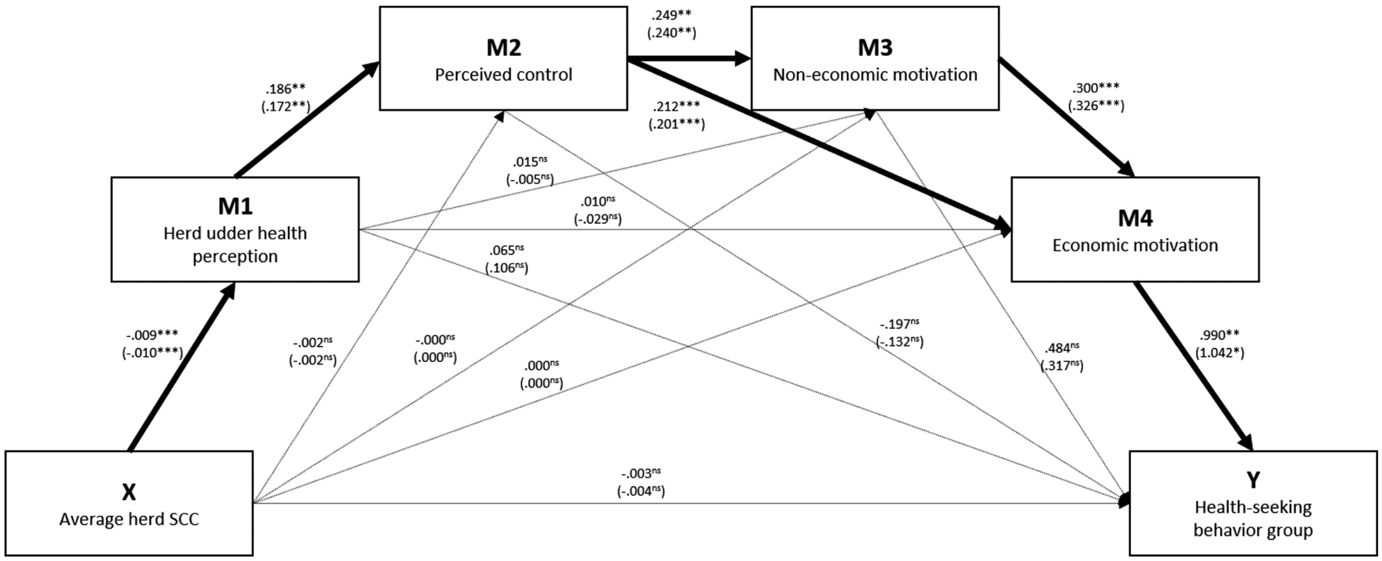

Figure 4. Coefficients for each association identified in the serial multiple mediator analysis investigating relationships between herd udder health status as indicated by the average herd SCC and farmers' health-seeking behavior, represented by whether and when they would contact a veterinarian or initiate treatment for cows in 3 fictive mastitis scenarios. Coefficients in parentheses represent the results of the model without covariates, production system (organic or conventional), and number of AMS units. For the model including all variables but no covariates, the overall model was significant, $P = 0.012$, Nagelkerke $R^2 = 0.13$. After adding covariates, the model again reached significance, $P = 0.002$, Nagelkerke $R^2 = 0.17$. A total of 164 farmers were included in the analysis (organic: n = 48; conventional: n = 116). Because the dependent variable was binary, the coefficient for the relationship between M4 and Y is expressed in log-odds, representing the change in the log of the odds of the outcome occurring. For ease of interpretation, significant paths can also be understood in terms of odds ratios, where values above 1 indicate increased odds of the outcome and values below 1 indicate decreased odds. Thick lines represent significant associations (*$P < 0.05$, **$P < 0.01$, ***$P < 0.001$, ns = not significant).

Vasquez et al., 2019; Lind et al., 2025). Farmers who perceive their herd's udder health as poor or feel less in control may delay or avoid treatment, regardless of actual herd-level indicators. This underscores the importance of understanding the psychological and motivational context in which farmers operate. A noteworthy finding is the direct influence of economic motivation on health-seeking behavior. Farmers who prioritized productivity and profitability were more likely to act promptly in response to mastitis symptoms. This supports earlier research suggesting that economic drivers are central to decision making in dairy operations (Valeeva et al., 2007; Hansson and Lagerkvist, 2016). In addition, the significant associations between M3 and M4 in the SMM models also strengthen previous studies showing that noneconomic values, such as animal welfare and taking pride in having healthy cows, also are important in decision making around udder health related issues (Valeeva et al., 2007; Hansson and Lagerkvist, 2014a,b).

When analyzing organic and conventional farmers separately, we found that the mediating pathways differed. Among organic farmers, perceived control and economic values had a direct effect on health-seeking behavior, whereas no significant pathway was observed among conventional farmers. This suggests that organic farmers may rely more on internalized motivations and a sense of agency in managing udder health. These differences may reflect broader contrasts in production philosophies, where organic systems often emphasize preventive care, reduced antibiotic use, and holistic animal welfare (Richert et al., 2013; Duval et al., 2017). However, in our survey, the importance of a low antibiotic use was found equally motivating by organic and conventional farmers, indicating that ideological differences were not the main reason for our observed differences between organic and conventional farms. Practices in conventional and organic dairy farming in Europe are similar, but previous studies indicate differences in attitudes toward veterinary support. Such differences include views on the role of the veterinarian, as a therapist or an advisor (Duval et al., 2017). In line with our results, Richert et al. (2013) found that organic farmers were more likely to delay initial veterinary contact for cows with subclinical mastitis compared with conventional farmers.

Our findings have several implications for advisory services and policy. First, interventions aimed at improving mastitis management should not focus solely on technical recommendations. By including farmers' udder health perceptions, sense of control and motivational values in udder health interventions, they have potential to become more context-sensitive and efficient. Motivational interviewing and participatory advisory approaches may be particularly effective to achieve this, as supported by previous studies (Jansen et al., 2009;

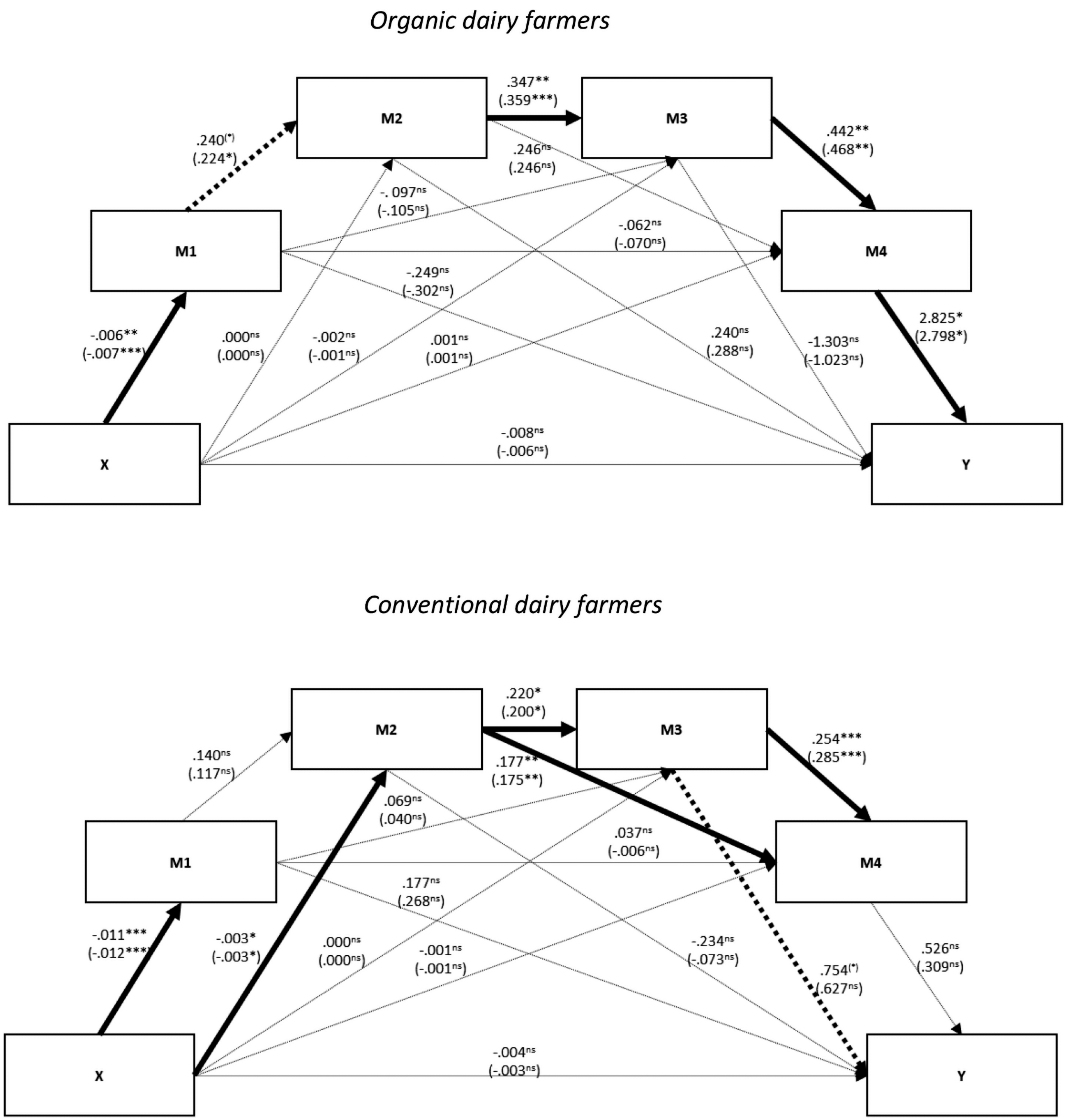

Figure 5. Serial multiple mediator (SMM) analyses for organic (n = 48) and conventional (n = 116) farms, investigating relationships between herd udder health status (indicated by the average herd SCC) and farmers' health-seeking behavior (represented by whether and when they would contact a veterinarian or initiate treatment for cows in 3 fictive mastitis scenarios). The results are presented with and without covariates (number of AMS units on the farm), with results without covariates in brackets. For organic farms, the model without covariates was marginally significant ($P = 0.057$, Nagelkerke $R^2 = 0.279$), just as the model with covariates ($P = 0.064$, Nagelkerke $R^2 = 0.313$). For conventional farms, the model without covariates was marginally significant ($P = 0.064$, Nagelkerke $R^2 = 0.115$), and with covariates again marginally significant ($P = 0.067$, Nagelkerke $R^2 = 0.133$). Because the dependent variable was binary, the coefficient for the relationship between M4 and Y is expressed in log-odds, representing the change in the log of the odds of the outcome occurring. For ease of interpretation, significant paths can also be understood in terms of odds ratios, where values greater than 1 indicate increased odds of the outcome and values less than 1 indicate decreased odds. Thick lines represent significant associations ($^{(*)}P < 0.07$, $^{*}P < 0.05$, $^{**}P < 0.01$, $^{***}P < 0.001$, ns = not significant).

Table 4. Results of a serial multiple mediator (SMM) model investigating how a herd's udder health status (represented by average herd SCC) was associated with farmers' health-seeking behavior, represented by if and when they would contact a veterinarian or initiate treatment for cows in 3 fictive mastitis scenarios[1]

	Step 1			Step 2			Step 3			Step 4			Step 5: Full model		
	(M1: Udder health perception)			(M2: Perceived control)			(M3: Noneconomic values)			(M4: Economic values)			(Y: HSB group)		
Item	Coeff.	SE	*P*-value	Coeff.	SE	*P*-value	Coeff.	SE	*P*-value	Coeff.	SE	*P*-value	Coeff.	SE	*P*-value
Model without covariate															
X (average herd SCC)	**−0.010**	**0.001**	**<0.001**	−0.002	0.001	0.114	0.000	0.001	0.564	0.000	0.001	0.687	−0.004	0.004	0.267
M1 (udder health perception)				**0.172**	**0.062**	**0.006**	−0.005	0.053	0.650	−0.029	0.045	0.518	0.106	0.208	0.612
M2 (perceived control)							**0.240**	**0.066**	**<0.001**	**0.201**	**0.058**	**0.001**	−0.132	0.283	0.642
M3 (noneconomic motivation)										**0.326**	**0.067**	**<0.001**	0.317	0.340	0.351
M4 (economic motivation)													**1.042**	**0.415**	**<0.05**
Constant	5.897	0.278	<0.001	3.715	0.424	<0.001	3.649	0.433	<0.001	2.530	0.441	<0.001	−5.206	2.401	<0.05
Model summary	$R^2 = 0.330$			$R^2 = 0.124$			$R^2 = 0.091$			$R^2 = 0.245$			Nagelkerke $R^2 = 0.127$		
	$F(162) = 79.617$, $P < 0.001$			$F(161) = 11.374$, $P < 0.001$			$F(160) = 5.356$, $P < 0.01$			$F(159) = 12.897$, $P < 0.001$			$\chi^2(5) = 16.38$, $P < 0.01$		
Model with covariates (number of AMS units and production type, conventional or organic)															
X (average herd SCC)	**−0.009**	**0.001**	**<0.001**	−0.002	0.001	0.082	0.000	0.001	0.599	0.000	0.001	0.939	−0.003	0.004	0.411
M1 (udder health perception)				**0.186**	**0.066**	**0.005**	0.015	0.056	0.788	0.010	0.047	0.825	0.065	0.226	0.774
M2 (perceived control)							**0.249**	**0.067**	**<0.001**	**0.212**	**0.058**	**<0.001**	−0.197	0.300	0.510
M3 (noneconomic motivation)										**0.300**	**0.067**	**<0.001**	0.484	0.347	0.163
M4 (economic motivation)													**0.990**	**0.435**	**<0.05**
Covariate: Production type	0.045	0.138	0.742	0.113	0.113	0.320	0.031	0.095	0.744	**−0.202**	**0.079**	**<0.05**	**−0.817**	**0.397**	**<0.05**
Covariate: Number of AMS units	**−0.235**	**0.065**	**<0.001**	0.091	0.055	0.100	0.036	0.047	0.439	**0.078**	**0.039**	**<0.05**	−0.025	0.186	0.892
Constant	6.050	0.311	<0.001	3.421	0.473	<0.001	3.443	0.458	<0.001	2.495	0.443	<0.001	−4.395	2.525	0.082
Model summary	$R^2 = 0.375$			$R^2 = 0.133$			$R^2 = 0.112$			$R^2 = 0.302$			Nagelkerke $R^2 = 0.173$		
	$F(156) = 31.193$, $P < 0.001$			$F(155) = 5.934$, $P < 0.001$			$F(154) = 3.896$, $P < 0.01$			$F(153) = 11.014$, $P < 0.001$			$\chi^2(7) = 22.26$, $P < 0.01$		

[1]Respondents (n = 164) were grouped into 2 health-seeking behavior groups (HSB 1, representing the most active health-seeking behavior, vs. HSB 2–4, representing less active behavior). These HSB groups were used as a binary variable, where HSB 1 = 1 and HSB 2–4 = 0. Latent variables (M1–M4) were included as mediators in the model and represent farmers' herd-level udder health perception (M1, if they considered the udder health in the herd as good), perceived control (M2, if they felt that they had control over the udder health situation on their farm), noneconomic motivation (M3, to what extent they were motivated to work with udder health related to noneconomic outcomes), and economic motivation (M4, to what extent they were motivated to work with udder health related to economic outcomes for the farm). For each step, additional variables are added to the regression. As the dependent variable was binary, the coefficients (Coeff.) in step 5 (full model, association between M4 and Y) are expressed in log-odds, representing the change in the log of the odds of the outcome occurring. For ease of interpretation, significant paths can also be understood in terms of odds ratios, where values above 1 indicate increased odds of the outcome and values below 1 indicate decreased odds. Significant results are marked in bold. Note that R^2 can decrease in mediation models because variance is redistributed across mediators, and adjusted R^2 may fall when additional predictors add little explanatory power.

Table 5. Results of a serial multiple mediator (SMM) model investigating how a herd's udder health status (represented by average herd SCC) was associated with farmers' health-seeking behavior, represented by if and when they would contact a veterinarian or initiate treatment for cows in 3 fictive mastitis scenarios[1]

	Step 1			Step 2			Step 3			Step 4			Step 5: Full model		
	(M1: Udder health perception)			(M2: Perceived control)			(M3: Noneconomic motivation)			(M4: Economic motivation)			(Y: HSB group)		
Item	Coeff.	SE	P	Coeff.	SE	P	Coeff.	SE	P	Coeff.	SE	P	Coeff.	SE	P
Organic farms (n = 48)															
X (average herd SCC)	**−0.006**	**0.002**	**0.002**	0.000	0.002	0.924	−0.002	0.001	0.207	0.001	0.001	0.408	−0.008	0.007	0.251
M1 (udder health perception)				**0.240**	**0.120**	**0.048**	−0.097	0.087	0.269	−0.062	0.102	0.546	−0.249	0.472	0.598
M2 (perceived control)							**0.347**	**0.106**	**0.002**	0.246	0.137	0.080	0.240	0.757	0.751
M3 (noneconomic motivation)										**0.442**	**0.178**	**0.017**	−1.303	0.979	0.183
M4 (economic motivation)													**2.825**	**1.224**	**0.021**
Covariate: Number of AMS units	**−0.311**	**0.144**	**0.037**	0.070	0.121	0.563	0.063	0.084	0.0456	0.054	0.098	0.584	0.528	0.456	0.246
Constant	5.589	0.521	<0.001	2.965	0.787	<0.001	3.744	0.630	<0.001	1.321	0.988	0.189	−6.616	5.376	0.218
Model summary	$R^2 = 0.298$			$R^2 = 0.101$			$R^2 = 0.240$			$R^2 = 0.315$			Nagelkerke $R^2 = 0.313$		
	$F(44) = 9.341$. $P < 0.001$			$F(43) = 1.616$. $P = 0.200$			$F(42) = 3.322$. $P < 0.05$			$F(41) = 3.778$. $P < 0.01$			$\chi^2(6) = 11.91$, $P = 0.064$		
Conventional farms (n = 116)															
X (average herd SCC)	**−0.011**	**0.001**	**<0.001**	**−0.003**	**0.001**	**0.020**	0.000	0.001	0.892	−0.001	0.001	0.468	−0.004	0.005	0.446
M1 (udder health perception)				0.140	0.080	0.083	0.069	0.073	0.344	0.037	0.052	0.476	0.177	0.275	0.519
M2 (perceived control)							**0.220**	**0.086**	**0.011**	0.177	0.063	**0.006**	−0.234	0.345	0.499
M3 (noneconomic motivation)										**0.254**	**0.069**	**0.000**	**0.754**	**0.391**	**0.054**
M4 (economic motivation)													0.526	0.515	0.307
Covariate: Number of AMS units	**−0.211**	**0.071**	**0.004**	0.094	0.062	0.134	0.031	0.056	0.580	**0.084**	**0.040**	**0.038**	−0.112	0.214	0.600
Constant	6.384	0.325	<0.001	4.024	0.580	<0.001	3.252	0.622	<0.001	2.699	0.498	0.000	−4.206	3.069	0.171
Model summary	$R^2 = 0.422$			$R^2 = 0.164$			$R^2 = 0.094$			$R^2 = 0.298$			Nagelkerke $R^2 = 0.133$		
	$F(110) = 40.171$. $P < 0.001$			$F(109) = 7.151$. $P < 0.001$			$F(108) = 2.811$. $P = 0.029$			$F(107) = 9.097$. $P < 0.001$			$\chi^2(6) = 11.78$, $P = 0.067$		

[1]The analysis was performed separately for organic (n = 48) and conventional (n = 116) dairy farms. Respondents were grouped into 2 different health-seeking behavior groups (HSB 1, representing the most active health-seeking behavior, vs. HSB 2–4, representing less active behavior). These HSB groups were used as a binary variable, where HSB 1 = 1 and HSB 2–4 = 0. Latent variables (M1–M4) were included as mediators in the model and represent farmers' herd-level udder health perception (M1, if they considered the udder health in the herd as good), perceived control (M2, if they felt that they had control over the udder health situation on their farm), noneconomic motivation (M3, to what extent they were motivated to work with udder health related to noneconomic outcomes), and economic motivation (M4, to what extent they were motivated to work with udder health related to economic outcomes for the farm). For each step, additional variables are added to the regression. As the dependent variable was binary, the coefficients (Coeff.) in step 5 (full model, association between M4 and Y) are expressed in log-odds, representing the change in the log of the odds of the outcome occurring. For ease of interpretation, significant paths can also be understood in terms of odds ratios, where values above 1 indicate increased odds of the outcome and values below 1 indicate decreased odds. Significant results are marked in bold. Note that R^2 can decrease in mediation models because variance is redistributed across mediators, and adjusted R^2 may fall when additional predictors add little explanatory power.

Svensson et al., 2019). The observed differences between organic and conventional farmers suggest that advisory strategies should be tailored to the values and motivations of different production systems. For organic farmers, who may be more ideologically driven or cautious about antibiotic use, communication should emphasize alignment with their broader goals, such as sustainability and animal welfare. For future research, it would be relevant to perform longitudinal designs to clarify causal pathways among herd health, perception, and behavior, as well as to develop typologies based on farmers' motivational profiles to better target interventions. How udder health perception and perceived control evolve over time and in response to changes in herd health or policy would also be relevant topics for future studies.

By focusing only on AMS herds, we ensured that the study population was relatively homogeneous with respect to technology and data access, which reduces variability and improves comparability within the sample. However, this also means that the results may not be directly generalizable to herds with conventional milking systems, where farmers rely more on visual observation and routine handling. Future studies should therefore include a larger and more diverse sample covering both AMS and conventionally milked herds. Such an approach would allow for a clearer understanding of whether the observed relationships are specific to AMS contexts or represent more general patterns across production systems. In addition, factors such as herd size and number of employees on the farm may also affect management strategies, and thus also affect decision making and health-seeking behaviors.

It should be pointed out that the term "health-seeking behavior" was used in a narrow sense of mastitis treatment in our study. The concept can entail several different aspects, such as incorporating preventive measures, seeking advice or engaging in other activities related to improving the udder health in the herd, which was not a part of the present study.

Several methodological limitations should be acknowledged. The decision to recategorize health-seeking behavior into a binary outcome was primarily motivated by statistical considerations, as the original 4-category chi-squared test showed a minor violation of assumptions. The binary classification ensured model assumptions were met and allowed us to apply logistic regression and mediation models in PROCESS, thereby providing a statistically robust framework for further analysis. However, this methodological choice also has interpretative implications. Although the binary outcome facilitates a clearer and more parsimonious interpretation, contrasting the most active health-seeking behavior in group HSB 1 with all other groups, it inevitably simplifies the complexity of farmers' health-seeking behaviors. Important distinctions among HSB groups 2, 3, and 4 are not captured in this approach. As a result, the binary model may overemphasize the contrast between types of production system, conventional and organic farmers, while masking more subtle, but potentially meaningful, gradations of behavioral intention. This trade-off highlights a broader methodological tension: ensuring statistical rigor versus preserving behavioral nuance. Researchers and policymakers should therefore interpret the results with caution. However, the binary model provides strong evidence of systematic differences in health-seeking behavior, both when analyzing all farmers and by separating them by organic or conventional production. Future research with larger samples could enable the use of multinomial logistic regression or structural equation model, thereby combining robust statistical inference with a richer understanding of behavioral diversity.

Furthermore, the cross-sectional design limits our ability to infer causality. It remains unclear whether a farmer's sense of control leads to better udder health, or whether good udder health fosters a stronger sense of control. Longitudinal studies are needed to disentangle these relationships. Also, the explanatory power of our model including the covariates was modest (R^2 = 0.173), indicating that other unmeasured factors likely influence farmers' treatment decisions. Social norms, past experiences, and veterinary relationships may also play important roles and calls for further investigations. It is also likely that response bias had some influence on the results. For example, in scenario 2 (subclinical mastitis), some farmers reported that they would treat the cow, despite national guidelines and veterinary recommendations advising against it. This could reflect a desire to provide the "correct" answer or uncertainty about best practices. The sample included a higher proportion of organic farms (29%) than the national average (18%), which may limit generalizability. However, other farm characteristics such as herd size, milk yield, and breed composition were representative of the broader Swedish dairy sector.

Finally, the choice of AHSCC as the independent variable should be discussed, as there are several other indicators that mirror the udder health situation in a dairy herd. Registrations of veterinary-treated clinical mastitis was considered as another option for representing herd level udder health status in the study. However, these registrations require action by the farmer, and are thus closely related to the farmer behavior and decision making this study set out to examine. We posit that active farmers that are motivated and quick to treat animals with udder health problems may consequently have a high rate of registered mastitis cases, reflecting a behavior rather than the actual udder health status within the herd. Thus, the individual cow SCC at DHI test milkings composed into an average SCC was here considered the best available objective measure to represent udder health status in the herd. Other indicators, such as the percentage of newly infected cows or culling reasons could have been useful indicators but was not available in our dataset. We thus acknowledge that the choice of AHSCC as herd-level udder health status indicator was based on practical reasons and may not fully capture the nuances of disease dynamics in a dairy farm.

CONCLUSIONS

Our results demonstrated that farmers' health-seeking behavior in mastitis management may be shaped more by subjective perceptions and motivations than by objective herd health indicators such as AHSCC. Specifically, herd-level udder health perception, perceived control, and both economic and noneconomic motivational values significantly influenced if and when farmers chose to initiate treatment or contact a veterinarian. Notably, economic motivation had a direct effect on decision making, particularly among organic farmers. These findings highlight the need for tailored advisory strategies that consider farmers' psychological and motivational profiles. By integrating these dimensions, it may be possible to design more effective, context-sensitive interventions that support both animal health and farmer well-being.

NOTES

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Nonstandard abbreviations used: AHSCC = average herd SCC; AMS = automated milking system; ASCM = acute severe clinical mastitis; Coeff. = coefficient; EFA = exploratory factor analysis; HSB = health-seeking behavior; RMCM = recurrent case of moderate clinical mastitis; SM = subclinical mastitis; SMM = serial multiple mediator; SOMRS = Swedish Official Milk Recording Scheme.

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