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1 **Development and validation of a measurement scale for self-efficacy for farmers'**
2 **mastitis prevention in dairy cows**

3

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17

18 **ABSTRACT**

19 The purpose of this study was twofold. First, we developed and validated the domain-specific
20 Mastitis Prevention Self-Efficacy scale (MPSES), derived from developing a corresponding
21 scale for the General Self-Efficacy Scale and consisting of 10 items describing dairy farmers'
22 feelings of confidence about being able to prevent, reduce and control mastitis, a common
23 infection of the udder. Second, farmers' cognitive assessment of mastitis was used in order to
24 explore the correlation of general and domain-specific self-efficacy. The MPSES was
25 completed by a sample of Swedish fulltime dairy farmers (n=290) through an online
26 questionnaire. The instrument was found to possess good reliability (Cronbach's alpha $\alpha=.90$)
27 and correlated well with the S-GSE ($r=.62$). Medium effects was identified by a correlation
28 between the MPSES and farmers' cognitive assessment of time-line ($r=0.3$, $p<0.001$), and
29 small effects for cure/control ($r=.12$, $p<0.05$) as well as for aspects related to cause ($r=.17-.28$,
30 $p<0.001$) of mastitis. The potential usefulness of this scale in the dairy industry is discussed.

31

32 **Keywords:** self-efficacy, mastitis prevention, farmer behaviour, illness perception, animal
33 welfare, animal health

34

35 INTRODUCTION

36 Self-efficacy is the concept widely used to explain the individual's self-evaluation of their
37 perceived ability to successfully execute, or, perceived control over, a certain situation or
38 behaviour to reach a desired outcome (Bandura, 1977, 1982, 1986; Wood & Bandura 1989).
39 The concept itself is not considered stable as it can fluctuate over time and be situation-specific
40 (Maddux et al., 1982; Luszczynska et al., 2005) which is explained by its multidimensionality
41 (Zimmerman, 2000). Existing work has examined self-efficacy in terms of general self-efficacy
42 (Sherer et al., 1982, Schwarzer et al., 1995; Luszczynska et al., 2005; Azizli et al. 2015) as well
43 as related to a wide set of specific domains including occupation, learning, stress, health, social
44 roles and/or role-specific self-efficacy (Hobfoll, 2002; Meier et al., 2008; Osborn et al. 2010;
45 Rubino et al., 2012).

46 Domain-specific efficacy has been suggested as being a strong behavioural predictor and most
47 suitable when analysing specific behaviour (Bandura & Wessels, 1997, Bandura, 1986; Pajares,
48 1996), whereas others have suggested that, when measuring self-efficacy in a more general
49 sense, it refers to a broad and stable concept (e.g. Sherer et al. 1982). Studies have reported
50 high predictability when using domain-specific self-efficacy measures, whereas, for general
51 self-efficacy, similar result could not be identified (Bandura & Wessels, 1997, Bandura, 1986;
52 Ferrari & Parker, 1992; Lindley & Borgen, 2002; Pajares, 1996). Overall, general self-efficacy
53 is considered to measure a motivational trait, which is a more stable and permanent perception
54 of one's own future performance, whereas domain-specific self-efficacy measures a
55 motivational state, a momentary perception which may be changed as a reaction to internal
56 and/or external triggers (e.g., Gardner & Pierce, 1998).

57 In this study, we focus on farmers' self-efficacy in relation to mastitis prevention. Keeping the
58 prevalence of mastitis low is important for a number of reasons. Mastitis is one of the most
59 common and most costly diseases in dairy cows and is, therefore, an economic burden on the

60 farmers (Hogeveen et al., 2011). It is caused by an infection in the cow's udder and causes pain
61 and suffering to the animal, meaning that it also impairs animal welfare. Mastitis is also
62 problematic as it is the predominant reason for antibiotic use in dairy farming (Teuber, 2001;
63 SOU, 2014). It also impairs the quality of the milk, causing it to be less useful in the food value
64 chain (Hogeveen et al., 2011).

65 In the context of self-efficacy and illness, perceived self-efficacy can refer to the belief that
66 one can establish control of health problems by learning about key aspects of care (Bandura,
67 1991; Holman & Lorig, 1992). A person's perception of an illness has been suggested to be
68 more strongly correlated with health outcome than with actual severity (Jones et al., 2014;
69 Rosenstock, 1966). This can be explained by the self-regulatory model (Leventhal, Diefenbach,
70 & Leventhal 1992; Leventhal et al., 1997) which suggests that individual responses to
71 perceived illness are based on situational stimuli (such as symptoms) which lead to cognitive
72 and emotional representations being generated as a reaction. This may take place in a three-
73 step process in which the individual first forms the representation of the illness (in our case:
74 farmers' perceptions of mastitis in their dairy herd), followed by them adopting coping
75 behaviours (adoption of preventive measures), and lastly, appraising the efficacy of these
76 behaviours (the perception of them having control of the situation). Studies have found, for
77 both individuals and caregivers, that having a better understanding of an illness and a high self-
78 efficacy are positively related to better compliance to treatment – and also improved health
79 (Zelber-Sagi et al., 2017; Griva et al., 2000). As farmers are the foremost caregivers of dairy
80 cows and responsible for taking necessary actions in order to ensure good animal health and
81 welfare, it can be expected that similarities may be found to previous literature on caregivers
82 in human illnesses.

83 The main objective of this study was to develop and validate the Mastitis Prevention Self-
84 Efficacy Scale (MPSES) for the dairy farmer population with the aim of measuring domain-

85 specific self-efficacy in relation to mastitis prevention. At this time, no study has yet
86 investigated domain-specific self-efficacy in the farming population.

87

88 **MATERIAL AND METHODS**

89 *Theoretical framework and approach*

90 Self-efficacy refers to individuals' beliefs concerning their ability to meet desired outcomes in
91 life. Initially, self-efficacy referred to the individual perception of capabilities in certain
92 domains (Bandura & Wessels 1997; Pajares 1996). Self-efficacy thus is a behaviour specific
93 psychological feature that can be learned and enhanced (Bandura, 1986; Lorig et al., 1993).

94 Self-efficacy theoretically originates from Bandura's Social Cognitive Theory (SCT; Bandura
95 1986), which suggests that humans are able to exercise self-motivation and control in order to
96 monitor their behaviour. According to theory, self-efficacy is believed to influence behaviours
97 and environments and in turn to be affected by them (Bandura 1986; Bandura & Wessels, 1997)
98 – meaning that a person's self-efficacy can be a direct result of their previous experience or
99 beliefs. As self-efficacy is specific to context and actual behaviour it is believed to change over
100 time based on human cognition, motivation, and behaviour (Bandura, 1997). When studying
101 self-efficacy in students, Ouweneel et al. (2013) found that changes in self-efficacy were
102 mainly due to engagement rather than actual performance. This was partly explained by the
103 fact that self-efficacy can vary over time.

104 Given that farmers are continuously working to prevent mastitis in their dairy herd, they
105 regularly obtain feedback on their performance (Bandura, 1997) through their exposure to the
106 task and use of preventive strategies. This would suggest that domain-specific self-efficacy is
107 more predictive than general self-efficacy in targeting farmers' perception of future beliefs in
108 performing a specific behaviour related to mastitis preventions.

109 Self-efficacy is considered to influence how individuals reason, experience emotions, and
110 incentivize themselves (Bandura & Wessels, 1997). Bandura and Wessels (1997) argued that,
111 in order to ensure proper assessment of self-efficacy, measurement should be targeted at the
112 actual domain of functioning rather than being measured on a general level. This means that
113 scale items should be directly related to the construct that is being measured (Bandura 2006).
114 Over the years, self-efficacy has been studied using a wide-range of methodological and
115 analytical approaches (Bandura & Locke 2003). While acknowledging Bandura's arguments
116 on the predictive power of domain-specific self-efficacy measures, others reason that
117 measuring generalized self-efficacy is beneficial for explaining behaviour in less specific
118 contexts (Schwarzer & Jerusalem, 1995; Sherer et al. 1982). Nonetheless, no amount of self-
119 efficacy, irrespective of whether it is general or domain-specific, will produce a competent
120 performance when the individuals lack the skills needed to succeed (Schunk 1995). Overall,
121 research has consistently shown that efficacy beliefs contribute significantly to the level of
122 motivation and performance of behaviour, as it can influence the choices people make and the
123 courses of action they pursue (Bandura & Locke 2003). Individuals tend to select tasks and
124 activities at which they feel competent and confident and avoid those at which they do not
125 (Bandura & Wessles 1997), as individuals will only be motivated when they possess the
126 necessary skills and incentives (Bandura, 1986).

127 To develop the Mastitis Prevention Self-Efficacy Scale (MPSES) , we used a two step-
128 procedure: First, we developed and validated a domain-specific questionnaire measure
129 MPSES, using the Swedish version of the validated measure General Self-efficacy scale, GSE
130 (Schwarzer et al., 1995; Löve et al., 2012). Second, we compared the domain-specific measure
131 MPSES with S-GSE with respect to its ability to explain farmers' cognitive
132 assessment/representation of mastitis as an illness, measured through aspects such as cause,
133 cure control, consequence and time-line of mastitis.

134

135 *Questionnaire and sample*

136 The study is based a data collection, performed on a random sample of Swedish full-time
137 farmers specializing in dairy production. The data collection was completed as an online
138 questionnaire study in the period April–June 2016.

139 All Swedish full-time farmers specializing in dairy production at the end of 2015 were eligible
140 for the study. At the end of 2015 the total population of Swedish dairy farmers were 4039.
141 Names, phone numbers, and addresses of a random sample of specialist dairy farmers were
142 obtained from a register of all Swedish farmers administered by Statistics Sweden (Örebro,
143 Sweden).

144 The survey was conducted by a third party specializing in survey data collection (IPSOS
145 Sweden, Stockholm) on behalf of the research group, and the research group obtained
146 anonymized data from the completed questionnaires.

147 An invitation letter containing the aims and objectives of the project was sent to respondents
148 together with a link to the online questionnaire. In total, 1,200 farmers were invited to
149 participate. Participating farmers were also given the option of completing the questionnaire
150 offline instead of completing the online version, thereby avoiding unintentionally leaving out
151 farmers with limited access to computers (n=42). Out of the sample of 1,200 farmers to which
152 the questionnaire was sent, 143 persons refused to participate due to time constraints, 42
153 refused to participate due to other reasons, 40 no longer matched the target group (either they
154 had retired or sold their dairy cows for other reasons), 3 declined participation due to illness,
155 and 62 of the phone numbers were faulty (farmers where reminded about the questionnaire
156 through phone by IPSOS). Prior to sending out the questionnaire, power estimations were
157 performed based on the total population of Swedish dairy farmers with a margin of error of 5%

158 and a confidence interval of 95% expecting a response rate of 30%. According to our estimation
159 we needed a total sample of at least 351 participants to be able to draw any statistical
160 conclusions. To ensure that the sample was big enough IPSOS Sweden reminded farmers about
161 the questionnaire until that requirement was fulfilled leaving us with a total of 356 (32.4%)
162 respondents. A comparison was made between the participating farmers based on the
163 background variables age and herd size, of the average Swedish dairy farmer in 2015, to
164 evaluate whether there were any reasons to assume that our sample differs from the whole
165 population of Swedish dairy farmers. Data for this comparison was obtained from the Swedish
166 Agriculture Statistical Yearbook (Jordbruksverket, 2015).

167 The questionnaire required 30–40 minutes to complete as it was part of a larger data collection,
168 and as a token of appreciation after completing the questionnaire each participating farmer was
169 sent two lottery tickets.

170 Post data collection additional data on herd health including bulk milk somatic cell count
171 (BMSCC) was obtained and matched to the participants from the Swedish Dairy Association.
172 Around 80% of all Swedish dairy farmers are associated with the Dairy Cow Recording
173 Scheme from which information about BMSCC was obtained. As our sample consisted of a
174 representative sample of all dairy farms in Sweden we were not able to match data for all
175 participating farms. Due to this 48 farms were excluded as we were not able to match data on
176 herd health, leaving us with a sample of 308 farms. A case and variable screening was
177 performed prior to data analysis for the dataset. As part of the questionnaire being administered
178 online, no missing data was found as the participants were unable to skip a question. Further
179 screening controlled for unengaged responses identified 18 participants who were excluded
180 from the data set as evidence showed that they responded in the same way for every item
181 meaning that no standard deviation was identified. After the screening, the data set consisted
182 of 290 participants.

183

184 *Scales and measures*

185 *General Self-Efficacy Scale (GSE)*

186 The General Self-Efficacy scale (GSE; Schwarzer et al., 1995) is comprised of ten items that
187 require individuals to rate the extent to which they agree with statements on a 4-point scale (1
188 = Not true at all, 4= Exactly true). Example items from this measure are, “I can always manage
189 to solve difficult problems if I try hard enough” and, “I can remain calm when facing
190 difficulties because I can rely on my coping abilities.” Previous studies have reported
191 Cronbach’s reliability coefficients for the GSE ranging from .75 to .91 when comparing studies
192 from 25 different countries (Scholz et al., 2002). For the present study, the Swedish version
193 was used, S-GSE (Löve et al., 2012) (see Table 2 for all items used in this study).

194

195 *Mastitis Prevention Self-Efficacy Scale (MPSES)*

196 The MPSES was derived from developing a corresponding scale to the S-GSE and consisted
197 of 10 items describing dairy farmers’ feelings of confidence about being able to prevent
198 mastitis, reducing the incidence and controlling the situation on the farm. Example items from
199 this measure are, “If problems arise in my herd and my dairy cows suffer from mastitis, I can
200 always manage to find an appropriate measure if I try hard enough,” and, “Thanks to my
201 resourcefulness, I know how to handle even surprising situations related to mastitis that can
202 occur in my herd.” (see Table 2 with all items which were used to test perceived self-efficacy
203 in mastitis prevention together with the items of the S-GSE). Each of the statements were rated
204 on a 4-point scale (1 = Not true at all, 4= Exactly true).

205

206 *Mastitis Illness Perception Questionnaire (M-IPQ)*

207 Questions related to farmers' cognitive assessment of mastitis as a production illness were
208 assessed using corresponding questions to the Illness Perception Questionnaire (IPQ; Weinman
209 et al., 1996) a scale commonly used to assess cognitive representation of an illness in human
210 medicine. The M-IPQ consisted of a total of 15 items, each item of the M-IPQ was constructed
211 based on the IPQ and reformulated to fit the farmer population and match conditions common
212 for mastitis in dairy herds. The original IPQ provide a rapid assessment of illness perception;
213 the purpose of reformulating the questions to fit the aim of this study was to develop a new
214 scale so as to enable assessment of farmers' perception of mastitis as a production illness. All
215 items were rated on a 5-point Likert scale from "disagree completely" to "agree completely"
216 (see Appendix 1 for all questions used). A principal axis factor analysis (PFA) was performed
217 to explore the dimensionality of the measure in order to evaluate whether the same factors as
218 those of the IPQ could be identified. Items with loadings greater than 0.4 were interpreted as
219 representing a particular factor. The content of the four factors, as defined by these item
220 loadings, provided confirmation of the theoretically derived factors related to consequence,
221 time-line, cause and cure-control. One exception to the criteria was the item "Mastitis in an
222 individual cow will pass quickly" which has a loading of 0.339 to the factor timeline (see
223 Appendix 1 for factor loadings and Cronbach alpha for each subscale). When using the scale
224 for the correlation analysis, three of the factors – time-line, consequences and cure-control were
225 obtained by adding all the scales items together and dividing by the number of items. For the
226 fourth scale, cause, it is recommended to handle each item separately as they each represent a
227 specific causal belief (Weinman et al., 1996).

228

229 ***Statistical methods***

230 We first used PFA in order to validate the developed domain-specific self-efficacy scale,
231 MPSES, in comparison to the general S-GSE. Second, we explored whether the domain

232 specific measure MPSES in comparison to the S-GSE was a better explanatory measure for
233 farmers' cognitive assessment/representation of mastitis as a production illness, measured
234 through aspects such as cause, cure control, consequence and timeline of mastitis using
235 Spearman correlation.

236 To examine the dimensionality of the MPSES in comparison to the S-GSE, PFA was conducted
237 using PROMAX rotation. PROMAX was chosen, as it allows for cross correlation between the
238 variables. A visual examination of a scree plot was used to determine the number of factors to
239 retain for the MPSES. To investigate internal consistency, inter-item correlations, Cronbach's
240 alpha and corrected item-total correlation were calculated for the MPSES for the total sample.
241 Convergent validity was examined by calculating the correlation between MPSES and the S-
242 GSE.

243 Questions corresponding to the Illness Perception Questionnaire (IPQ: Weinman et al., 1996)
244 were developed to target farmers' cognitive assessment of mastitis in their dairy cows,
245 constituting the Mastitis Illness Perception Questionnaire (M-IPQ). PFA, using the same
246 settings as above, was used to identify whether the scale consisted of the four factors related to
247 i) consequence, ii) time-line, iii) cause and iv) cure control (as identified in the original IPQ
248 scale). In order to compare MPSES with S-GSE with respect to its ability to explain M-IPQ,
249 farmers' cognitive representation, Spearman correlation was performed. For the correlation
250 analysis farmers' subjective evaluation of the BMSCC at the herd, measures of actual BMSCC,
251 herd size and milking system was included in the analysis as they are believed to have an effect
252 on how the farmer works with preventing mastitis. Milking system included as three separate
253 binary variables representing pipeline, parlor and automatic milking systems. All estimations
254 were run using SPSS version 24 (SPSS, IBM Corp., IBM SPSS Statistics for Windows, Version
255 24.0, Armonk, NY, USA).

256

257 **RESULTS**

258 Descriptive statistics on the sample of farmers participating in the first questionnaire is
259 presented in Table 1. Based on the sample used for the present study, the participating farmers
260 are slightly older than the average farmer in 2015 and hold more dairy cows than average.

261 Internal consistency reliability was high for both the S-GSE scale ($\alpha = .88$) and the MPSES
262 scale ($\alpha = .90$). Table 3 shows the factor loadings for the MPSES scale. Principle factor analysis
263 of the MPSES scale supported a unidimensional structure with eigenvalue=5.40 for the first
264 factor accounting for 54% of the total MPSES item variance. In contrast, analysis reveals that
265 the GSE scale was two-dimensional, accounting for 59.6% of the total item variance.

266 In order to test the internal consistency of the MPSES, the corrected item-total correlations of
267 the total sample ranged from .28 to .65. Item-total correlations did not indicate improvement
268 or impairment for the removal of any of the items (part of the instruments) for the entire sample.
269 Communalities ranged from .39 to .59. According to Kaiser's criterion and a visual
270 examination of the scree plot, only one factor was retained in the factor analyses for MPSES
271 (see Table 3 for details of factor loadings for MPSES). Convergent validity was examined by
272 calculating the correlations between S-GSE and MPSES. For the total sample, the correlations
273 between S-GSE and MPSES were $r = .62$, $p < 0.001$ (See Table 4 for descriptive statistics and
274 inter correlations for the MPSES and S-GSE together with variables used for exploratory
275 purpose).

276 In order to compare the domain specific measure MPSES with the S-GSE in respect to its
277 ability to explain farmers' cognitive assessment/representation of mastitis as a production
278 illness, questions from the M-IPQ were used. As a first step, the factor structure of M-IPQ was
279 explored using PFA based on which four items were dropped, leaving a total of 11 items being

280 used for the present study which loaded on four factors. The four items were dropped due to
281 low loading on all identified four factors (see Appendix 1). For the Spearman correlation
282 analysis, three factors i) consequence, ii) time-line, iii) cure control were used, for the items
283 corresponding to cause, the items were used individually.

284 Results of the Spearman correlation (see Table 5 for results) indicated that there was a small
285 effect with weak but significantly positive correlation between MPSES and cure control
286 ($r=0.12$, $p<0.05$), between MPSES and two of the three items related to cause (r ranging from
287 $.17$ - $.28$, $p<0.001$) and a medium effect between MPSES and timeline ($r=0.32$, $p<0.001$), but
288 not for consequence ($r=-0.03$, $p=0.58$) (Field, 2009). For S-GSE the results of the Spearman
289 correlation indicated that there was a significantly and positive but weak association between
290 S-GSE and timeline ($r=.20$, $p<0.001$) and between S-GSE and two of the items related to cause
291 (r ranging from $.18$ - $.26$, $p<0.001$).

292

293 **DISCUSSION**

294 This study developed a scale for domain-specific self-efficacy in mastitis prevention, MPSES,
295 and evaluated it in relation to general self-efficacy, S-GSE, in the Swedish dairy farming
296 population. The study is based on responses from a set of 290 dairy farmers. Compared with
297 the average Swedish dairy farmer in 2015, the respondents were older and had larger dairy
298 herds, which may imply that our results are representative especially for farmers who possibly
299 are more experienced and where the dairy production is of greater economic significance. We
300 found both measures, MPSES and S-GSE, to be internally consistent ($\alpha=.90$ and $\alpha=.88$
301 respectively). PFA performed for the two instruments revealed the MPSES scale to be
302 unidimensional whereas the GSE scale consisted of two dimensions. Analyses comparing the
303 domain specific instrument with the general instrument S-GSE suggest that they are highly
304 correlated. The dimensionality of the S-GSE has previously been discussed, as some

305 researchers have suggested that it is unidimensional (Löve et al., 2012 (Swedish version),
306 Scholz et al., 2002) and others have suggested that it is multidimensional (Bosscher & Smit,
307 1998; Chen et al., 2001; Woodruff & Cashman, 1993). The theoretical assumptions that self-
308 efficacy can fluctuate over time and be situation specific supports the suggestion that the
309 construct consist of multiple dimensions (Zimmerman, 2000), as does the fact that the general
310 measure explains self-efficacy in a non-specific situation. In a domain-specific scale, however,
311 we argue that unidimensionality is plausible as it is related to self-efficacy in a specific
312 situation. By using the General Self-efficacy Scale (GSE; Schwarzer et al., 1995), and
313 developing corresponding questions related to self-efficacy in mastitis prevention (described
314 as MPSES), our expectation is that the domain-specific measure developed here will be
315 valuable in understanding farmers' perceptions of being able to handle the situation on the farm
316 related to the preventive work regarding mastitis.

317 The results of this study indicate that both general and domain-specific self-efficacy is
318 weakly correlated with farmers' assessment of the items corresponding to cause. These
319 results indicate that farmers' perceptions of their self-efficacy can, both on a general as well
320 as domain-specific level, partly explain the variation of the assessment of mastitis as an
321 illness. In general, our result may point to MPSES and the S-GSE being measures which
322 cover different types of domain, as is suggested by the way in which the two measures are
323 phrased. The domain-specific scale intended to capture farmers' self- efficacy in relation to
324 mastitis specifically corresponds to more of the domains of the M-IPQ measure than the
325 general scale. The findings are mainly explained by the items comprising farmers' cognitive
326 assessment of being able to understand its cause. For cure control these factors were only
327 related to the domain-specific scale suggesting that farmer's perception of self-efficacy in
328 mastitis prevention is a predictor among farmers. Considering the factor for cure control,
329 items such as "My actions will not affect the outcome of mastitis in my herd" (see Appendix

330 1 for all items) suggest that farmers who perceives a high self-efficacy also rate themselves as
331 more able to cure and control the situation. Moreover, the aspects related to time-line
332 (“Mastitis among my cows will only be a short-term problem, which will then disappear
333 completely” and “Mastitis among my cows will probably be a permanent rather than a
334 temporary problem”) together suggest an understanding of the illness as a continuum, rather
335 than a feeling of being able to control the situation. This could be considered in relation to
336 previous studies suggesting that having a better understanding of an illness and high self-
337 efficacy are positively related to better compliance with treatment – and also improved health
338 (Zelber-Sagi et al., 2017; Griva et al., 2000). The items related to cure-control and
339 consequences have previously shown a higher test-retest reliability than the scale related to
340 Time-line in humans (Weinman et al., 1996) This was argued to be a result from people
341 suffering from an illness perceiving the consequences and cure of their illness to be less
342 likely to change over time, which may have more serious consequences. Related to time-line,
343 results have shown that having a higher score means that the individual perceives it as less
344 likely that the illness is controllable or curable, leading to severe personal consequences
345 (Weinman et al., 1996). However, our results suggest that neither the MPSES, nor the S-GSE
346 are strong predictors of farmers’ perceptions of the consequence of mastitis, as indicated by
347 small and medium effects identified by the correlation coefficients (Field 2009). Neither one
348 of the self-efficacy scales was correlated with the factor related to perceived consequence of
349 dairy cows having mastitis, consisting of the items “cows in my herd suffering from mastitis
350 is a serious condition” and “my cows suffering from mastitis causes serious consequences for
351 their well-being”. This can be explained by the fact that neither one of the items comprise
352 areas in which farmers have the possibility to act.

353 In relation to other psychological concepts, such as Theory of Planned Behavior (Ajzen &
354 Fishbein 1975), self-efficacy is considered as one of the most important precondition for

355 behavioral change, since it determines the individuals' initiation of coping behavior and
356 perception of his or her own capabilities. This may be compared to perceived behavioral
357 control, which is part of the Theory of planned behavior, which rather explains an individuals'
358 actual ability to perform a behavior. Measuring self-efficacy is an easy way to explain how
359 well an individual perceives him or herself able to cope with a certain situation and may
360 therefore be a more appropriate instrument in measuring and screening possible differences in
361 farmers adoption of strategies in order to control diseases in the own herd.

362 As self-efficacy is a changeable psychological state rather than a permanent personality trait
363 (Ouweneel et al., 2013), one would expect some variation in the responses over time within
364 individuals. Although the present results indicate that the MPSES on its own may be a predictor
365 of farmers assessment of mastitis as an illness as well as a perception of their possibility to act
366 preventively, more research is needed where individuals are followed over time to study
367 whether farmers' self-efficacy can be improved.

368 Mastitis in dairy production is problematic due to its adverse effects on farm financial results,
369 the usefulness of milk in the food value chain (Hogeveen et al., 2011), animal welfare and
370 antibiotic use (Teuber, 2001). Reducing the prevalence of mastitis is thus important from a
371 business point-of-view, both for the farm businesses and the dairy plant processors. It is also
372 important from a societal perspective as poor animal welfare can in itself be considered a
373 negative externality in animal production but most of all it is bad for the animals.

374 Furthermore, reducing the use of antibiotics in animal production would be one important
375 step in reducing the risk of antibiotic resistance and leakage of medical residue into the water
376 supply. MPSES, as developed in this study, is expected to be useful in agricultural sectors,
377 both for practicing veterinarians as well as for research, as this scale can provide a rapid
378 assessment of farmers' perceptions of being able to perform a specific behaviour for illness
379 prevention as well as providing insights into farmer's behaviour in relation to mastitis

380 prevention both in Sweden and internationally. This would allow for the development of
381 targeted efforts in order to improve animal health, which will have positive consequences for
382 farm profitability, animal welfare, the avoidance of antibiotics use and the usefulness of the
383 milk in the food value chain. The ultimate goal with the instrument is that it can be used by
384 veterinarians and other animal health advisors in their efforts to assist farmers in reducing the
385 prevalence of mastitis in their herds. The MPSES may also be used internationally after
386 certain adaption to fit the target group and its specific situation regarding animal health. In
387 particular, MPSES can be used as an instrument to screen farmers' self-efficacy in relation to
388 mastitis prevention in dairy cows. This can be used as a basis for providing more individually
389 adjusted advice to different farmers. This is supported by previous studies showing positive
390 effects by training and increasing the own expectancy of self-efficacy on actual performance
391 accomplishment where individuals who received more training prior to performing the actual
392 behavior had a higher success rate (Holloway & Watson 2002). In particular, this will be
393 useful for identifying those farmers with relatively low levels of MPSES, who are likely
394 candidates for more thorough advice in order to improve their feelings of capacity to affect
395 mastitis prevalence in their herds. In this way, veterinarians and other animal health advisors
396 will be able to better prioritize their time and other resources among different farmers
397 depending on their level of MPSES. MPSES is also a likely candidate to explain differences
398 in farmers' uptake of different types of mastitis prevention measures in their herds.
399 Consequently, this study provides support for the MPSES being used as a self-efficacy
400 measure for dairy farming population behaviour related to animal health that can be useful in
401 future research aiming at explaining such uptake as well as in advisory services.

402

403 **CONCLUSION**

404 In conclusion, our findings suggest that the MPSES scale may help to assess motivation and
405 performance in farmers' work in preventing mastitis. In particular, MPSES enables an easy and
406 accessible way of quickly measuring farmer's beliefs in their ability to act (illness prevention)
407 in the future.

408

409 **Conflict of interest statement**

410 None of the authors have any financial or personal relationships that would inappropriately
411 influence the findings in this study.

412

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416

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