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Prevalence of subclinical ketosis and production diseases in dairy cows in Central and South America, Africa, Asia, Australia and New Zealand, and Eastern Europe

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22 **Abstract**

23 Subclinical ketosis (SCK) and periparturient diseases considerably account for
24 economic and welfare losses in dairy cows. The majority of scientific reports investigating the
25 prevalence of SCK and production diseases are based on empirical studies conducted in
26 Western Europe and North America. The present study surveyed the prevalence of SCK and
27 production-related clinical diseases in early lactating cows in various countries across the
28 world other than those in North America and Western Europe. Twelve countries of South and
29 Central America (Argentina, Brazil, Chile, Colombia, Mexico), Africa (South Africa), Asia
30 (Thailand, China), Eastern Europe (Russia, Ukraine), Australia and New Zealand were
31 assessed, and data from a total of 8,902 cows kept at 541 commercial dairy farms were
32 obtained. A minimum of 5 cows per farm were blood sampled and examined once after
33 parturition up to day 21 of lactation. Blood concentration of β -hydroxybutyrate (BHBA) was
34 measured (threshold for SCK: 1.2 mmol/l) and the presence of production-related diseases
35 such as milk fever, retained placenta, mastitis, metritis, displaced abomasum, claw disease
36 and clinical ketosis was recorded. More than 95% of all cows were examined in their second
37 week of lactation. Across all investigated countries, the SCK prevalence was 24.1%, ranging
38 from 8.3% up to 40.1%. The prevalence of production-related diseases detected during the
39 first 21 days of lactation was relatively low (< 5%). Calculated odds ratios did not indicate an
40 elevated risk for production diseases in cows with SCK. Despite differences in production
41 systems across countries and variation between individual farms within a region, the present
42 study data on SCK prevalence align with observations in Western European and North
43 American dairy herds. At the very early stage of sampling and clinical examination for
44 detection of SCK, it cannot be excluded that certain production diseases such as DA,
45 lameness and mastitis have developed later.

46

47 **Introduction**

48 At the onset of lactation, dairy cows experience a marked metabolic load due to the
49 prevailing negative energy balance, which makes them susceptible towards infectious and
50 metabolic diseases [1, 2]. Increased concentrations of circulating ketone bodies,
51 predominantly β -hydroxybutyrate (BHBA), without the presence of clinical signs of ketosis
52 are considered as subclinical ketosis (SCK; [3]). The blood BHBA thresholds for SCK
53 diagnosis in literature range between 1.2 and 1.4 mmol/l [4-8]. Although symptoms of clinical
54 ketosis such as reduced milk production, lethargy and loss of appetite are commonly observed
55 at higher concentrations of BHBA (>3.0 mmol/l), some cows, however, may be exposed to
56 high BHBA concentrations without showing any clinical signs, whereas others develop
57 ketosis characteristics already at lower BHBA levels [2, 9, 10].

58 SCK affects performance and is obviously related to an increased risk of production-
59 related diseases such as clinical ketosis, displaced abomasum (DA), retained placenta, and
60 metritis [11, 12]. Concomitantly, production efficiency decreases (e.g. lower milk production,
61 poor fertility, and increased culling rates) which results in economic losses [11-15]. Serum
62 BHBA concentrations ≥ 1.2 mmol/l in the first week after calving were associated with a
63 several fold increased risk of subsequently developing DA and metritis, respectively [11].
64 Ospina et al. [16] found increased risk ratios of 4.9 for clinical ketosis, 2.3 for metritis and 6.9
65 for DA when plasma BHBA concentrations exceeded a threshold of 1.0 mmol/l during days 3
66 to 14 post partum. A negative impact of SCK on milk yield of early lactating cows was
67 reported by several authors [10-12, 17]. Furthermore, cows with BHBA concentrations above
68 1.0 mmol/l in the first week after calving were significantly less likely to be diagnosed
69 pregnant after first insemination [13]. The economic impact of SCK is therefore indisputable,
70 although exact figures quantifying the actual costs of SCK are difficult to collect. Based on an
71 earlier investigation on Canadian dairy farms including more than 2,600 cows, McLaren et al.

72 [18] estimated that a reduction of 1% in SCK incidence would amount to a saving of 584
73 USD per year. Recently, McArt et al. [14] calculated the average total costs of
74 hyperketonemia (blood BHBA concentrations ≥ 1.2 mmol/l) to be 289 USD per case
75 diagnosed.

76 Prevalence of SCK in the existing literature ranges between 10 and 40% in early
77 lactation with highest values occurring within the first three weeks of lactation [11, 17, 19].
78 Most of these studies, however, included only a small number of dairy herds and cows
79 (mainly research stations), and were performed in North America and Western Europe [5-8,
80 12].

81 The objective of the present study was to survey the prevalence of SCK and the
82 concomitant occurrence of health disorders in early lactating dairy cows in various countries
83 across the world other than those in North America and Western Europe. Dairy farms in 12
84 countries of South and Central America (Argentina, Brazil, Chile, Colombia and Mexico),
85 Africa (South Africa), Asia (Thailand, China), Eastern Europe (Russia, Ukraine), Australia
86 and New Zealand were investigated. To our knowledge, this is the first large-scale approach
87 to investigate the prevalence of SCK beyond Western Europe and North America.

88

89 **Materials and methods**

90 **Ethics statement**

91 All procedures in terms of blood sampling and veterinary examinations followed the
92 animal care and welfare legislation criteria of the involved countries. The approval was
93 provided by the local responsible institutions of the following countries: Argentina, Australia,
94 Brazil, Chile, China, Colombia, Mexico, New Zealand, Russia, South Africa, Thailand and
95 Ukraine.

96 **Animals, blood sampling and analysis**

97 The study was conducted from June 2011 to September 2013 at different commercial
98 dairy farms in 12 different countries worldwide (Argentina, Australia, Brazil, Chile, China,
99 Colombia, Mexico, New Zealand, Russia, South Africa, Thailand and Ukraine). Breeds
100 included were dairy breeds (e.g. predominantly Holstein Friesian, Jersey), local crossbred
101 lines (e.g. Girolondo in Brazil, Simmental x Red Steppe in Russia) and others (e.g.
102 Simmental). Management systems varied from grazing systems to indoor housing of animals
103 throughout the year. In total, 8,902 early lactating dairy cows housed on 541 farms were
104 evaluated. At least five randomly selected cows of a herd in early lactation (day 2 to 21 post
105 partum (p.p.)) inconspicuous of obvious health disorders and without any previous treatments
106 were clinically examined and blood was sampled for diagnostic purposes and health
107 monitoring during regular herd health management visits by veterinarians in the field. Each
108 cow was only tested once and no further restrictions in selection criteria such as parity
109 number, breed, or performance were implied. In all cows, blood samples were taken from the
110 coccygeal vein, and BHBA concentrations were directly determined on site using a handheld
111 meter (Precision Xceed, Abbott Diabetes Care Inc., Alameda, CA, USA), which was
112 previously validated for the use in cows [20, 21]. Concomitantly, each sampled cow was
113 clinically examined for the presence of metabolic and infectious health disorders (milk fever,
114 retained placenta, displaced abomasum (DA), claw disease, mastitis, metritis and clinical
115 ketosis (CK)) following standardized diagnostic definitions (Table 1).

116 **Table 1. Definitions used for disease diagnosis during veterinary examinations of dairy**
117 **cows in early lactation.**

Postpartum disease	Definition	Reference
Milk fever	Cow requires Ca injections due to hypocalcaemia, based on clinical	[29-31]

	signs such as muscular weakness or lying cow unable to rise.	
Retained placenta	Failure to pass placenta within 24 h after calving	[29, 30]
Mastitis	Visually abnormal milk appearance and/or changes in the appearance of the udder (inflammatory signs, swollen or hard quarters)	[29, 30, 32]
Displaced abomasum	Presence of gas-filled abomasum on left or upper right flank, based on a characteristic “ping” sound at auscultation or percussion, confirmed by surgery	[29, 30]
Claw disease	Abnormal findings during claw examinations (such as interdigital and digital dermatitis) and/or lameness with a locomotion score ^a of ≥ 3 (scale of 1-5).	[29, 30, 33]
Metritis	Enlarged uterus and/or purulent, smelly uterine discharge associated with systemic signs (fever ^b , inappetence/anorexia, inactivity, decreased milk yield)	[29, 30, 34]
Clinical ketosis	Decreased milk production, reduced feed intake or inappetence, reduced activity, positive blood, milk or urine ketone test, absence of DA or other primary disease, ketone odor in breath or milk	[29, 30]

118 ^ascale 1 to 5.

119 ^bbody temperature $>39.5^{\circ}\text{C}$.

120

121 **Statistical analysis**

122 Cows sampled between day 2 and 21 p.p. were categorized “SCK negative” if blood
 123 BHBA concentrations were <1.2 mmol/l, or “SCK positive” when BHBA concentrations
 124 were ≥ 1.2 mmol/l). The prevalence of SCK was calculated as proportion of animals with
 125 BHBA concentrations ≥ 1.2 mmol/l relative to all investigated cows. Prevalence data were
 126 estimated at country and average global level. In addition, overall and country-specific
 127 prevalence of postpartum diseases was calculated. The occurrence of postpartum diseases in
 128 relation to SCK was evaluated by odds ratio (OR) analyses using the statistical package
 129 TESTIMATE (version 6.5, idv-Data Analysis & Study Planning, Krailling, Germany)
 130 according to following formula: $\text{OR} = (p_1/(1-p_1)) / (p_2/(1-p_2))$, where p_1 indicates the

131 probability of postpartum diseases under SCK conditions and p_2 the probability of postpartum
 132 diseases under non-SCK conditions.

133

134 Results

135 Data analyses were based on a total of 8,902 dairy cows from 541 different
 136 commercial dairy farms. The number of farms investigated per country and their herd size
 137 ranged from two farms with 83 cows in Thailand to 102 farms housing 2,989 cows in New
 138 Zealand. On average, cows of the present dataset were in their 3rd lactation (range of parity
 139 number: 1 - 14, 26.9% primiparous and 73.1% multiparous dairy cows; Table 2). The
 140 majority (95.1%) of the cows was examined and sampled between days 7 and 15 p.p..

141 **Table 2. Information on animals and farms of the different participating countries in the**
 142 **present study.**

Country	Farms (n)	Cows (n)	Percentage of cows		Cattle breed	Housing	Parity number ^a	Milk yield (kg/d per cow)
			primiparous	multiparous				
Argentina	27	720	26.0	74.0	Holstein-Friesian	Pasture and indoors	2.8 ± 1.8	28.5
Australia	22	208	15.0	85.0	Holstein-Friesian	Pasture	3.4 ± 2.0	18.4
Brazil	26	159	35.5	64.5	50% Holstein-Friesian, 50% others (Girolondo, Gyr, Brown Swiss)	Pasture and indoors	2.5 ± 1.7	13 - 30
Chile	17	183	24.6	75.4	Holstein-Friesian	Pasture and indoors	2.6 ± 1.3	23.0
China	41	404	63.1	36.9	Holstein-Friesian	Indoors	1.3 ± 1.5	25 - 35
Colombia	79	791	27.1	72.9	Holstein-Friesian, Brahman, Brahman crossbred	Pasture	2.9 ± 1.8	17 - 21
Mexico	63	2,060	37.6	62.4	Holstein-Friesian or	Pasture and	2.3 ± 1.7	18 - 22

					HF crossbred	indoors		
New Zealand	102	2,989	13.7	86.3	Holstein-Friesian, Jersey, HF/Jersey crossbred	Pasture	4.0 ± 2.4	13 - 19
Russia	77	764	39.3	60.7	Holstein-Friesian, Simmental, Red Steppe	Indoors	2.2 ± 1.2	13 - 23
South Africa	54	377	18.1	81.9	Holstein-Friesian	Pasture	3.3 ± 1.9	20 - 25
Thailand	2	83	32.5	67.5	88% Holstein-Friesian	Indoors	3.3 ± 2.3	12 - 20
Ukraine	31	164	21.3	78.7	50% Holstein-Friesian, 50% others	Indoors	2.6 ± 1.3	13 - 25
Overall	541	8,902	26.9	73.1			3.0 ± 2.1	

143 ^aData are expressed as mean values ± SD.

144 **Concentration of blood BHBA and subclinical ketosis**

145 Blood BHBA concentrations observed between day 2 and day 21 p.p. were
146 1.0 ± 0.8 mmol/l, ranging from an average value of 0.7 mmol/l (Australia, Brazil, Colombia
147 and Russia) up to 1.5 mmol/l (Ukraine). In two thirds of the investigated countries, mean
148 BHBA concentrations were below 1.0 mmol/l (0.7 - 0.9 mmol/l) while in one third of the
149 countries (namely China, New Zealand, Thailand and Ukraine) mean BHBA concentrations
150 of 1.0 mmol/l and above were observed (Table 3). Blood BHBA concentrations of 3.0 mmol/l
151 and beyond during the first 21 days of lactation were predominately observed in China and
152 Ukraine (Table 3). Overall, SCK (BHBA concentrations ≥1.2 mmol/l) was diagnosed in
153 24.1% of all cows examined, ranging from 8.3% (Colombia) up to 40.1% (New Zealand;
154 Fig 1). In only two (Australia and Colombia) out of the 12 investigated countries, SCK
155 prevalence on the participating farms was less than 10%. In four countries (Brazil, Chile,
156 Mexico, Russia) SCK prevalence varied between 10.7% and 14.8%, whereas in the remaining
157 countries (Argentina, China, New Zealand, South Africa, Thailand, Ukraine) SCK prevalence

158 was above 15% (between 17.0% and 40.1%). More than 80% of all cows diagnosed SCK
 159 were multiparous. In contrast, we observed SCK occurring more frequently in primiparous
 160 cows in three countries (Chile, South Africa, Ukraine; Fig 2).

161 **Table 3. Blood BHBA concentrations in early lactating dairy cows (2- 21 days**
 162 **postpartum) in different countries and proportion of cows with highly elevated BHBA**
 163 **concentrations.**

Country	BHBA concentration (mmol/l)			Cows with BHBA ≥ 3.0 mmol/l	
	n	mean \pm SD	range	n	%
Argentina	720	0.9 \pm 0.9	0.1 - 6.2	36	5.0
Australia	208	0.7 \pm 0.7	0.1 - 7.0	4	1.9
Brazil	159	0.7 \pm 0.6	0.1 - 4.8	3	1.9
Chile	183	0.8 \pm 0.7	0.0 - 4.6	3	1.6
China	404	1.2 \pm 1.0	0.0 - 5.8	33	8.2
Colombia	791	0.7 \pm 0.4	0.1 - 4.2	4	0.5
Mexico	2,060	0.8 \pm 0.7	0.0 - 6.0	53	2.6
New Zealand	2,990	1.2 \pm 0.7	0.0 - 8.0	101	3.4
Russia	764	0.7 \pm 0.7	0.1 - 6.4	18	2.4
South Africa	376	0.9 \pm 1.0	0.1 - 7.2	20	5.3
Thailand	83	1.0 \pm 0.8	0.1 - 5.8	2	2.4
Ukraine	164	1.5 \pm 1.5	0.0 - 6.7	22	13.4
Overall	8,902	1.0 \pm 0.8	0.0 - 8.0	299	3.4

164
 165 **Fig 1. Prevalence of subclinical ketosis worldwide.** Prevalence of subclinical ketosis (SCK,
 166 blood BHBA concentrations ≥ 1.2 mmol/l) in early lactating dairy cows studied in 12
 167 countries worldwide.

168
 169 **Fig 2. Subclinical ketosis in primi- and multiparous dairy cows.** Occurrence of subclinical
 170 ketosis (SCK, blood BHBA concentrations ≥ 1.2 mmol/l) in primiparous and multiparous
 171 cows during early lactation in different countries worldwide.

172

173 **Prevalence of concomitant production diseases and their**
 174 **association with SCK**

175 The overall prevalence of production diseases was 4.3% for milk fever, 4.0% for
176 retained placenta, 3.4% for mastitis, 1.7% for claw disease and 5.3% for metritis (Table 4).
177 Displaced abomasum (DA) and clinical ketosis showed a very low prevalence (0.3% and
178 0.7%, respectively). During the first 21 days p.p., DA was not seen in 50% (6/12) of the
179 investigated countries and CK was diagnosed in only 7 out of 12 countries. We further
180 investigated the relationship of SCK with the concomitant presence of health disorders in
181 early lactation by performing an odds ratio analysis. However, due to the generally low
182 prevalence of diseases, odds ratios (OR) were <1 , and an increased risk of disease in
183 association with SCK could not be identified in the present study (data not shown). The
184 highest odds ratio was calculated for clinical ketosis as cows diagnosed SCK had a 1.062
185 higher probability of having subsequently clinical ketosis.

186 **Table 4. Prevalence of production diseases between 2 and 21 days postpartum.**

Country	Milk fever		Retained placenta		Mastitis		DA ^a		Claw disease		Metritis		CK ^b	
	%	n	%	n	%	n	%	n	%	n	%	n	%	n
Argentina	0.7	(5/720)	2.1	(15/720)	5.1	(37/720)	1.0	(7/720)	2.2	(16/720)	15.7	(113/720)	4.0	(29/720)
Australia	10.1	(21/208)	7.2	(15/208)	3.8	(8/208)	0	(0/208)	0.5	(1/207)	6.3	(13/208)	1.9	(4/208)
Brazil	0	(0/159)	8.8	(14/159)	3.8	(6/159)	0.6	(1/159)	1.3	(2/159)	0	(0/159)	0	(0/159)
Chile	7.1	(13/182)	5.5	(10/183)	9.3	(17/183)	1.1	(2/183)	5.5	(10/183)	9.8	(18/183)	2.2	(4/183)
China	1.7	(7/403)	4.0	(16/404)	2.0	(8/404)	2.7	(14/404)	1.0	(4/404)	3.7	(15/404)	1.2	(5/404)
Colombia	1.5	(12/791)	4.3	(34/791)	4.6	(36/791)	0.1	(1/791)	1.0	(8/791)	0.9	(7/791)	0	(0/791)
Mexico	0.6	(13/2060)	4.7	(97/2060)	1.4	(29/2060)	0.2	(4/2060)	1.3	(27/2060)	5.7	(118/2059)	0.6	(12/2060)
New Zealand	0.7	(20/2990)	0.2	(7/2990)	1.2	(36/2990)	0	(0/2990)	0.1	(3/2990)	0.3	(10/2990)	0.1	(2/2989)
Russia	37.4	(286/764)	17.0	(130/764)	14.9	(114/764)	0	(0/764)	10.5	(80/764)	13.5	(103/764)	0.9	(7/764)
South Africa	0.8	(3/377)	1.3	(5/377)	0.8	(3/377)	0	(0/377)	0	(0/377)	6.6	(25/377)	0	(0/377)
Thailand	1.2	(1/83)	0	(0/83)	4.8	(4/83)	0	(0/83)	1.2	(1/83)	19.3	(16/83)	0	(0/83)
Ukraine	0.6	(1/164)	7.3	(12/164)	3.7	(6/164)	0	(0/164)	0.6	(1/164)	19.5	(32/164)	0	(0/164)
Overall	4.3	(382/8901)	4.0	(355/8903)	3.4	(304/8903)	0.3	(26/8903)	1.7	(153/8902)	5.3	(470/8902)	0.7	(63/8902)
Range	0 - 37.4 %		0 - 17.0 %		0.8 - 14.9 %		0 - 2.7 %		0 - 10.5 %		0 - 19.5 %		0 - 4.0 %	

187 ^aDA = displaced abomasum.

188 ^bCK = clinical ketosis.

189 **Discussion**

190 In the last three decades, research results addressing SCK and periparturient diseases
191 represented primarily published data from the United States, Canada and Western Europe [6,
192 12, 22]. The majority of reports usually based on investigations conducted in regional and
193 small-sized dairy farms of individual countries [8, 16, 18, 19]. Studies involving a higher
194 number of animals and covering wider geographic areas were presented earlier by Chapinal et
195 al. [23] and Suthar et al. [6], but still considered only SCK occurrence within Europe and the
196 United States, respectively. Different study designs and scopes (such as pre- or postpartum
197 reclassification of animals, herd or cow level investigations, sampling of blood, milk or urine,
198 and defining SCK at various BHBA thresholds) do not always allow a straight forward
199 comparison of literature data across farms, regions and countries, as recently described in a
200 meta-analysis evaluating 23 SCK publications by Raboisson et al. [22]. Furthermore, data on
201 global SCK prevalence obtained by a standardized protocol for sampling and defining SCK
202 are scarce. Therefore, we have investigated the prevalence of SCK and typical production-
203 related disorders in early lactating dairy cows in various countries across the world other than
204 those in North America and Western Europe. By using the same validated tool for on-site
205 BHBA testing in all cows, diagnosing SCK at the generally accepted blood BHBA cut-off
206 concentration of 1.2 mmol/l and sampling cows in the very early lactation (days 2 to 21 p.p.)
207 make the results presented here comparable to studies performed in other countries.

208 The overall SCK prevalence of the present survey was in a comparable range to
209 observations from a European evaluation of Suthar et al. [6]. In addition, the variation in the
210 global SCK rates presented here highly scatters (approximately 8 - 40%) and is similar to
211 findings reported for US and Europe [6, 8, 12]. The majority of our investigated cows with
212 SCK were multiparous confirming the assumptions that the risk of developing SCK increases
213 with parity number as milk production rises concomitantly [24]. Based on an analysis of a

214 variety of publications, Oetzel [19] considered a prevalence rate of 15% representative for
215 SCK in dairy herds, but emphasized to consider a SCK prevalence of 10% already as an alert
216 level. In the present study only 2 out of 12 countries (Australia and Colombia) had an average
217 SCK prevalence of less than 10%, whereas the remaining countries had higher rates. Four
218 countries (China, New Zealand, Ukraine, and Thailand) revealed even SCK rates up to 40%.
219 However, this does not exclude that SCK may also occur at higher rates in the countries with
220 low SCK prevalence in the present study which might be attributed to the random selection of
221 farms and animals. In general SCK in early lactating dairy cows is globally present. The
222 highest average SCK prevalence of all countries was observed in New Zealand. One
223 explanation might be that dairy cows in New Zealand are mostly kept under extensive pasture
224 based production conditions with low or even zero concentrate supplementation [7]. Along
225 with the genetic progress in dairy cow breeding, milk production in export-oriented countries
226 such as New Zealand likely increased and aggravated the energy deficiency in early lactating
227 cows [2, 25]. In another study, Compton et al. [7] observed a lower SCK prevalence of
228 approximately 17% in New Zealand dairy cows, which would be still in the upper range when
229 compared to the present evaluations. The difference just implies the possible variation due to
230 the selection of farms and animals.

231 Interestingly, the occurrence of postpartum diseases of the present study was much
232 lower compared to literature reports. Our observations on average prevalence rates of retained
233 placenta, mastitis, claw diseases and metritis were approximately half of the values reported
234 in a European study by Suthar et al. [6]. At first sight, these results were surprising
235 considering the fact that SCK prevalence rates of this investigation were in agreement with
236 other reports published. The cows diagnosed SCK in the present study did obviously not
237 develop health disorders at this early sampling stage. However, results of the concomitant
238 presence of SCK and further production diseases are inconsistent. While we observed the

239 highest SCK prevalence on farms in New Zealand, postpartum diseases occurred only at less
240 than 1% in cows diagnosed SCK. On the other hand, the SCK prevalence data in Russia were
241 only moderately high (14.1%), but many health disorders were diagnosed at the same time
242 (milk fever 37.4%, retained placenta 17.0%, mastitis 14.9%, claw disease 10.5%). In a recent
243 study by Zbinden et al. [10], high-yielding cows fed only herbage showed blood BHBA
244 concentrations approaching that representative for clinical ketosis, however, not necessarily
245 followed by the occurrence of diseases. Irrespective of the concomitant presence of
246 production diseases in cows with SCK, elevated BHBA concentrations ≥ 1.2 mmol/l
247 undoubtedly increase the risk of subsequently developing further health disorders [11, 16] at
248 simultaneously reduced performance in terms of milk yield and reproduction [11-13, 17].
249 Management and environmental conditions are crucial factors that affect the ability of cows to
250 cope successfully with the imposed metabolic load. These circumstances cannot be effectively
251 recorded in a field study like the present one. Furthermore, one might speculate on regional
252 differences in terms of breed and feeding system affecting the development of health
253 disorders. The occurrence of DA was reported to be relatively rare in dairy cattle in New
254 Zealand and Australia [7, 26], which is assumed to be associated with the predominantly
255 extensive farming on pasture where important risk factors for DA such as low locomotion
256 activity are not important. However, prevalence of DA concomitant with SCK in the present
257 study was in particular low in countries with a more intensive milk production in confined
258 housing systems (e.g. China, Russia, Thailand, and Ukraine). Similar observations were made
259 for mastitis and the occurrence of lameness. Although lameness may also occur in cattle on
260 pasture, it appears to be less frequent and to be usually based on a different aetiology [27, 28].
261 In contrast, we observed that mastitis prevalence in cows with SCK can be elevated
262 independent if cows were kept on pasture or indoors.
263

264 **Conclusions**

265 In conclusion, findings of the present study showed that SCK in dairy cows is a global
266 issue and can be observed at various rates in many countries over the world. Possibly due to
267 the diagnosis of SCK and clinical examination at a very early stage of lactation, concomitant
268 postpartum diseases in cows diagnosed for SCK have not yet developed at this stage. An
269 appropriate management is crucial for avoiding a deterioration of animals' metabolic status
270 with the associated negative impacts on health and performance. The results of the present
271 study support the hypothesis that the association between SCK and postpartum diseases is
272 complex and that based on an occasional single determination of blood BHBA concentrations
273 alone, a reliable and robust prediction of further production diseases is not possible.

274

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280

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