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Supplemental Table S1. Overall incidence rate of cases during the preweaning period (per 65.7 calf-days at risk).

Reported Primary Clinical Sign	Incidence rate
Digestive	0.196
Respiratory	0.122
Concurrent digestive and respiratory	0.021
Other*	0.111
Any	0.450

***Other included calves reported as only dull or dehydrated or febrile, and calves with reported infections, injuries, lameness, or neurological signs.*

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Supplemental Table S2. Incidence rate of exclusive clinical cases per calf-month at risk

Reported primary clinical sign	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Digestive	0.055	0.076	0.062	0.081	0.038	0.049	0.047	0.062	0.05	0.042	0.052	0.086
Respiratory	0.045	0.032	0.062	0.044	0.041	0.03	0.032	0.025	0.019	0.041	0.028	0.031
Concurrent digestive and respiratory	0.007	0.003	0.002	0.008	0.002	0.008	0.003	0.004	0.006	0.012	0.004	0.003
Other*	0.053	0.051	0.049	0.051	0.034	0.025	0.041	0.039	0.025	0.042	0.010	0.045
Any	0.159	0.163	0.174	0.184	0.115	0.113	0.124	0.130	0.101	0.137	0.094	0.165

***Other included calves reported as only dull or dehydrated or febrile, and calves with reported infections, injuries, lameness, or neurological signs.*

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Supplemental Table S3. Incidence rates by exclusive cases per calf-week at risk from birth to weaning. *****Other included calves reported as only dull or dehydrated or febrile, and calves with reported infections, injuries, lameness, or neurological signs

Clinical sign	Week 0	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8	Week 9	Week 10
Digestive	0.0051	0.0448	0.0727	0.0263	0.0090	0.0075	0.0055	0.0043	0.0020	0.0008	0.0000
Respiratory	0.0059	0.0098	0.0102	0.0086	0.0098	0.0169	0.0134	0.0122	0.0102	0.0047	0.0020
Concurrent digestive and respiratory	0.0012	0.0031	0.0039	0.0024	0.0008	0.0008	0.0024	0.0004	0.0000	0.0004	0.0004
Other*	0.0055	0.0306	0.0259	0.0177	0.0134	0.0094	0.0059	0.0047	0.0016	0.0024	0.0008

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Supplemental Table S4. Percent of heifer calves for all categorical variables initially included in morbidity univariate screening, by morbidity status. Bolded variables were considered for inclusion in the multivariable model (*P*-value < 0.20).

				Calves by reported morbidity (%)		
Initial model variable	Variable level	Calves (n)	Calves (%)	No disease events	Any disease events	*P*-value
All calves		2374	100.0%	66.1%	33.9%	
Region*	East	1495	63.0%	62.5%	63.8%	0.879
	West	879	37.0%	37.5%	36.2%	
Herd size	Small (30-99 cows)	314	13.2%	13.4%	12.9%	0.904
	Medium (100-499 cows)	658	27.7%	26.7%	29.7%	
	Large (500+ cows)	1402	59.1%	59.9%	57.3%	
Breed	Holstein	2127	89.6%	90.4%	88.1%	0.692
	Jersey	101	4.3%	3.9%	4.9%	
	Other	142	6.0%	5.4%	7.1%	
	Not reported	4	0.2%	0.3%	0.0%	
Calving ease	Unassisted/easy extraction	2110	88.9%	88.9%	88.8%	0.951
	Difficult/mechanical extraction	112	4.7%	5.0%	4.2%	
	Not reported	152	6.4%	6.1%	7.0%	
Attendance at the calving event	Attended	1186	50.0%	49.7%	50.5%	0.918
	Unattended	940	39.6%	40.0%	38.8%	
	Not reported	248	10.4%	10.3%	10.7%	
Single vs. twins	Single	2221	93.6%	93.2%	94.3%	0.233
	Twin	80	3.4%	3.0%	4.1%	
	Not reported	73	3.1%	3.8%	1.6%	
Navel disinfected	Yes	1822	76.7%	77.3%	75.7%	0.645
	No	513	21.6%	20.5%	23.8%	
	Not reported	39	1.6%	2.2%	0.5%	
Gender of the primary	Male	1438	60.6%	62.4%	57.0%	**0.015**

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caretaker	Female	806	34.0%	30.8%	40.0%	
	Both	130	5.5%	6.8%	3.0%	
Primary housing ventilation	Natural ventilation	1895	79.8%	84.1%	71.5%	**0.033**
	Other ventilation	479	20.2%	15.9%	28.5%	
Housing number	Groups less than 9	2223	93.6%	95.5%	89.9%	**0.111**
	Groups greater than 9	151	6.4%	4.5%	10.1%	

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Initial model variable	Variable level	Calves (n)	Calves (%)	Calves by reported morbidity (%)		
				No disease events	Any disease events	*P*-value
Bedding	Straw/hay	1272	53.6%	51.6%	57.5%	0.853
	Shavings/woodchips	507	21.4%	22.4%	19.3%	
	None	282	11.9%	12.9%	9.8%	
	Combination	313	13.2%	13.1%	13.4%	
Vaccines given during the preweaning period	Yes	1534	64.6%	61.8%	70.1%	**0.075**
	No	840	35.4%	38.2%	29.9%	
Antibiotic preventatives given during the preweaning period	Yes	51	2.1%	2.9%	0.7%	**0.112**
	No	2323	97.9%	96.9%	99.3%	
Dehorning/ disbudding	Yes	1194	50.3%	52.0%	46.9%	0.470
	No	1081	45.5%	43.2%	50.1%	
	Not reported	99	4.2%	4.8%	3.0%	
Giardia	Positive	658	27.7%	28.8%	25.6%	0.201
	Negative	1518	63.9%	63.1%	65.5%	
	Not tested	198	8.3%	8.1%	8.8%	
Cryptosporidium	Positive	940	39.6%	40.8%	37.3%	0.532
	Negative	1237	52.1%	51.2%	53.9%	
	Not Tested	197	8.3%	8.0%	8.8%	
Liquid diet type	Whole/waste milk	1403	59.1%	55.2%	66.8%	**0.052**
	Any milk replacer	971	40.9%	44.8%	33.2%	
Direct fed microbial additives in the liquid diet	Yes	381	16.0%	13.4%	21.0%	**0.110**
	No	1993	84.0%	86.5%	79.0%	
Evaluation of bacterial counts in the milk	Yes	259	10.9%	9.8%	13.1%	0.446
	No	1271	53.5%	56.6%	47.6%	
	Not applicable (fed MR)	844	35.6%	33.6%	39.3%	
Additives in the milk	Yes	1246	52.5%	53.3%	50.9%	0.529
	No	1128	47.5%	46.7%	49.1%	
Antibiotics in the milk	Yes	322	13.6%	13.1%	14.6%	0.769

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	No	2052	86.4%	86.9%	85.4%	
Pasteurized milk	Yes	662	27.9%	29.4%	24.9%	0.720
	No	868	36.6%	36.9%	35.8%	
	Not applicable (fed MR)	844	35.6%	33.6%	39.3%	
Milk delivery system	Bottle	597	25.1%	28.7%	18.3%	0.390
	Bucket/pail	358	15.1%	14.1%	16.9%	
	Milk bar	70	2.9%	2.3%	4.2%	
	Robotic	47	2.0%	0.8%	4.4%	
	Bottle and bucket	1145	48.2%	48.3%	48.1%	
	Other combination	157	6.6%	5.9%	8.1%	

** West region: California, Colorado, Washington; East region: Iowa, Michigan, Minnesota, Missouri, New York, Ohio, Pennsylvania, Vermont, Virginia, and Wisconsin*

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Supplemental Table S5. Continuous variables initially evaluated for morbidity of heifer calves. Bolded variables were included in the initial morbidity model (*P*-value less than 0.20)

									Reported Morbidity				
				Percentile					No disease events		Any disease events		
Variable	Number of calves	Mean	SE	5th	25th	50th	75th	95th	Mean	SE	Mean	SE	*P*-value
Birth weight (kg)	2,374	42.63	0.11	34.04	39.09	42.73	45.91	52.27	42.88	0.14	42.1	0.2	**0.067**
Serum IgG	2,374	21.77	0.22	6.20	14.40	20.90	28.30	40.20	22.48	0.27	20.4	0.4	**0.001**
Amount of protein fed per day (kg)	2,374	0.20	0.00	0.10	0.14	0.17	0.23	0.35	0.19	0.00	0.2	0.0	**0.185**
Amount of fat fed per day (kg)	2,374	0.21	0.00	0.10	0.15	0.19	0.24	0.33	0.20	0.00	0.2	0.0	0.385
Average THI during the preweaning period (pTHI)*	2,374	49.60	0.35	18.50	36.30	52.55	63.80	70.70	50.61	0.42	47.6	0.6	**0.007**
Average daily gain (kg)	2,073	1.60	0.01	0.79	1.25	1.57	1.91	2.53	1.62	0.01	1.6	0.0	0.391

**THI provides an index that accounts for the effects of temperature and relative humidity, and the equation uses the dry bulb temperature (T, ºF) and the relative humidity (RH). The equation for THI used for this analysis was: THI = T – (0.55 – (0.55 x RH/100) x (T – 58).*

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Supplemental Table S6. Percent of heifer calves for all categorical variables initially included in mortality univariate screening, by mortality status. Bolded variables were considered for inclusion in the multivariable model (*P*-value < 0.20).

				Calves by reported mortality (%)		
Initial model variable	Variable level	Calves (n)	Calves (%)	Died	Survived to weaning	*P*-value
All calves		2272	100.0%	5.00%	95.00%	
Region*	East	1398	61.5%	53.2%	61.95%	0.314
	West	874	38.5%	46.8%	38.05%	
Herd size	Small (30-99 cows)	276	12.1%	10.1%	12.25%	
	Medium (100-499 cows)	637	28.0%	24.8%	28.20%	0.653
	Large (500+ cows)	1359	59.8%	65.1%	59.55%	
Breed	Holstein	2025	89.1%	90.8%	89.04%	
	Jersey	101	4.4%	4.6%	4.44%	0.777
	Other	142	6.3%	4.6%	6.33%	
	Not reported	4	0.2%	0.0%	0.18%	
Calving ease	Unassisted/easy extraction	2017	88.8%	84.4%	89.00%	
	Difficult/mechanical extraction	101	4.4%	2.8%	4.72%	0.454
	Not reported	142	6.3%	12.8%	6.29%	
Single vs. twins	Single	2122	93.4%	91.7%	93.48%	
	Twin	78	3.4%	1.8%	3.51%	0.530
	Not reported	72	3.2%	17.4%	3.01%	
Navel disinfected	Yes	1734	76.3%	82.6%	76.01%	
	No	499	22.0%	17.4%	22.19%	0.307
	Not reported	39	1.7%	0.0%	1.80%	
Gender of the primary caretaker	Male	1378	60.7%	63.3%	60.52%	
	Female	769	33.8%	32.1%	33.93%	0.420
	Both	125	5.5%	4.6%	5.55%	
Primary housing ventilation	Natural ventilation	1839	80.9%	80.7%	80.95%	
	Other ventilation types	433	19.1%	19.3%	19.05%	0.718

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Housing number	Groups less than 9	2121	93.4%	95.4%	93.25%	0.201
	Groups greater than 9	151	6.6%	4.6%	6.75%	

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Initial model variable	Variable level	Calves (n)	Calves (%)	Calves by reported mortality (%)		*P*-value
				Died	Survived to weaning	
Bedding	Straw/hay	1203	52.9%	50.5%	53.07%	0.533
	Shavings/woodchips	472	20.8%	16.5%	21.45%	
	None	282	12.4%	21.1%	11.97%	
	Combination	305	13.4%	11.9%	13.50%	
Vaccines given during the preweaning period	Yes	1463	64.4%	51.4%	65.05%	0.087
	No	809	35.6%	48.6%	34.95%	
Antibiotic preventatives administered during the preweaning period	Yes	51	2.2%	2.8%	2.22%	0.714
	No	2221	97.8%	97.2%	97.78%	
Dehorning/disbudding	Yes	1145	50.4%	0.0%	52.94%	**<0.001**
	No	1028	45.2%	100.0%	0.00%	
	Not reported	99	4.4%	0.0%	4.58%	
Morbidity during the preweaning period	Any disease	761	33.5%	68.8%	68.28%	
	No disease	1511	66.5%	31.2%	31.72%	
Liquid diet type	Whole/waste milk	1315	57.9%	55.0%	58.02%	0.763
	Any milk replacer	957	42.1%	45.0%	41.98%	
Kg of fat in liquid diet per day	≤ 0.15 kg/day	686	30.2%	51.4%	29.13%	**0.028**
	016-0.21 kg/day	765	33.7%	24.8%	34.12%	
	≥0.22 kg/day	821	36.1%	23.9%	36.75%	
Direct fed microbial additives in the liquid diet	Yes	381	16.8%	11.0%	17.06%	**0.118**
	No	1891	83.2%	89.0%	82.94%	
Any additives in the liquid diet	Yes	1184	52.1%	43.1%	52.57%	**0.146**
	No	1088	47.9%	56.9%	1.20%	
Antibiotics added in the liquid diet	Yes	322	14.2%	8.3%	14.47%	**0.062**
	No	1950	85.8%	91.7%	85.53%	
Evaluation of bacterial counts in the liquid diet	Yes	259	11.4%	11.0%	11.42%	0.363
	No	1232	54.2%	46.8%	54.60%	
	Not applicable (fed MR)	781	34.4%	42.2%	33.98%	
Pasteurized milk	Yes	662	29.1%	21.1%	33.98%	**0.137**

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Milk delivery system	No	829	36.5%	36.7%	41.98%	0.362
	Not applicable (fed MR)	781	34.4%	42.2%	24.04%	
	Bottle	589	25.9%	35.8%	25.43%	
	Bucket/pail	357	15.7%	11.9%	15.90%	
	Milk bar	24	1.1%	0.9%	1.06%	
	Robotic	47	2.1%	1.8%	2.08%	
	Bottle and bucket	1104	48.6%	46.8%	48.68%	
	Other combination	151	6.6%	2.8%	6.84%	

** West region: California, Colorado, Washington; East region: Iowa, Michigan, Minnesota, Missouri, New York, Ohio, Pennsylvania, Vermont, Virginia, and Wisconsin*

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Supplemental Table S7. Continuous variables initially evaluated for mortality of heifer calves. Bolded variables were included in the initial mortality model (*P*-value less than 0.20)

				Percentile					Reported mortality				
									Died		Survived to weaning		
Initial model variable	No. of calves	Mean	SE	5th	25th	50th	75th	95th	Mean	SE	Mean	SE	*P*-value
Birth weight (kg)	2,272	42.6	0.1	33.9	39.1	42.7	45.9	52.3	41.0	0.6	42.6	0.1	**0.033**
Serum IgG (g/L)	2,272	21.8	0.2	6.2	14.5	21.0	28.4	40.1	17.7	1.1	22.0	0.2	**0.002**
Liquid diet protein per day (kg)	2,272	0.2	0.0	0.1	0.1	0.2	0.2	0.3	0.2	0.0	0.2	0.0	**0.019**
Average THI during the preweaning period (pTHI)*	2,272	49.7	0.4	18.4	37.6	52.6	63.8	70.7	49.5	1.8	49.7	0.4	**0.012**

**THI provides an index that accounts for the effects of temperature and relative humidity, and the equation uses the dry bulb temperature (T, ºF) and the relative humidity (RH). The equation for THI used for this analysis was: THI = T – (0.55 – (0.55 x RH/100) x (T – 58).*

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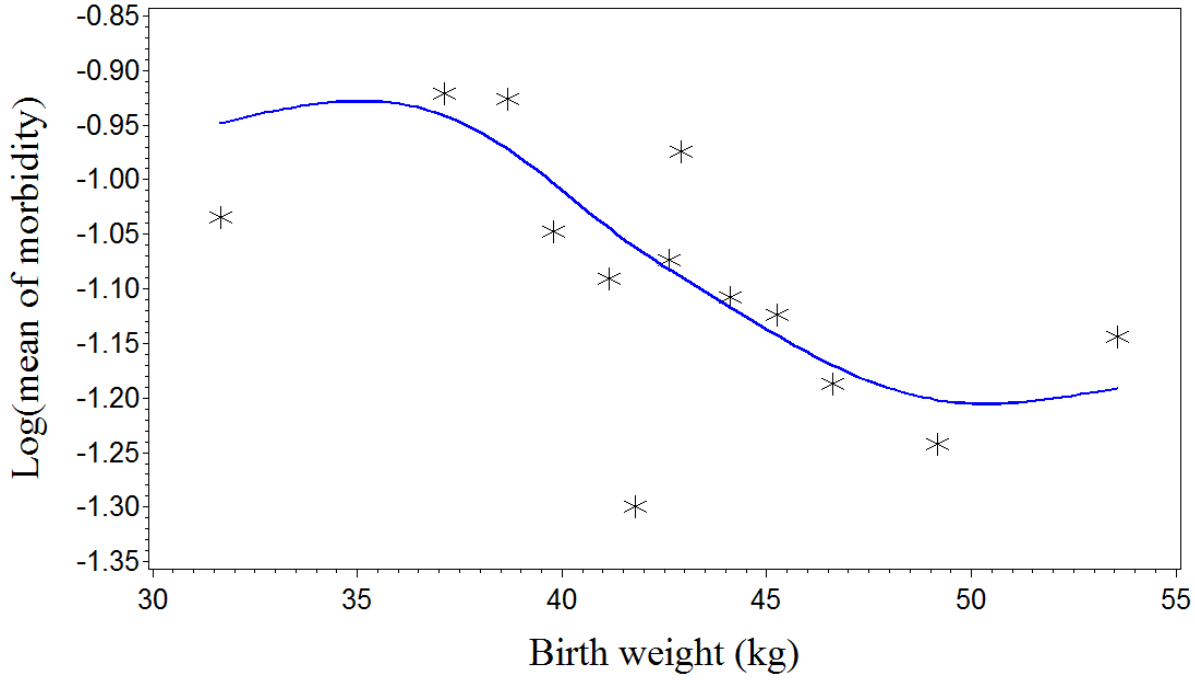
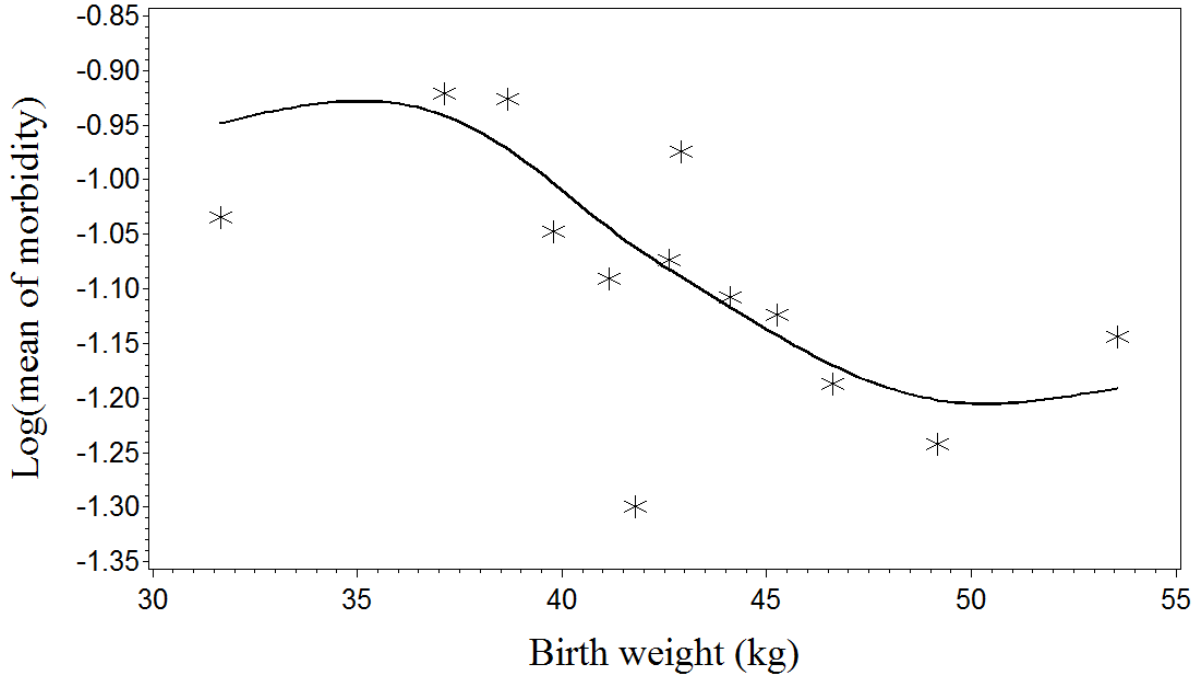
Supplemental Figure S1. Predicted morbidity risk for preweaned heifer calves by (a) birth weight (kg), (b) serum IgG (g/L), and (c) average monthly THI concentration grouped into 12 categories.





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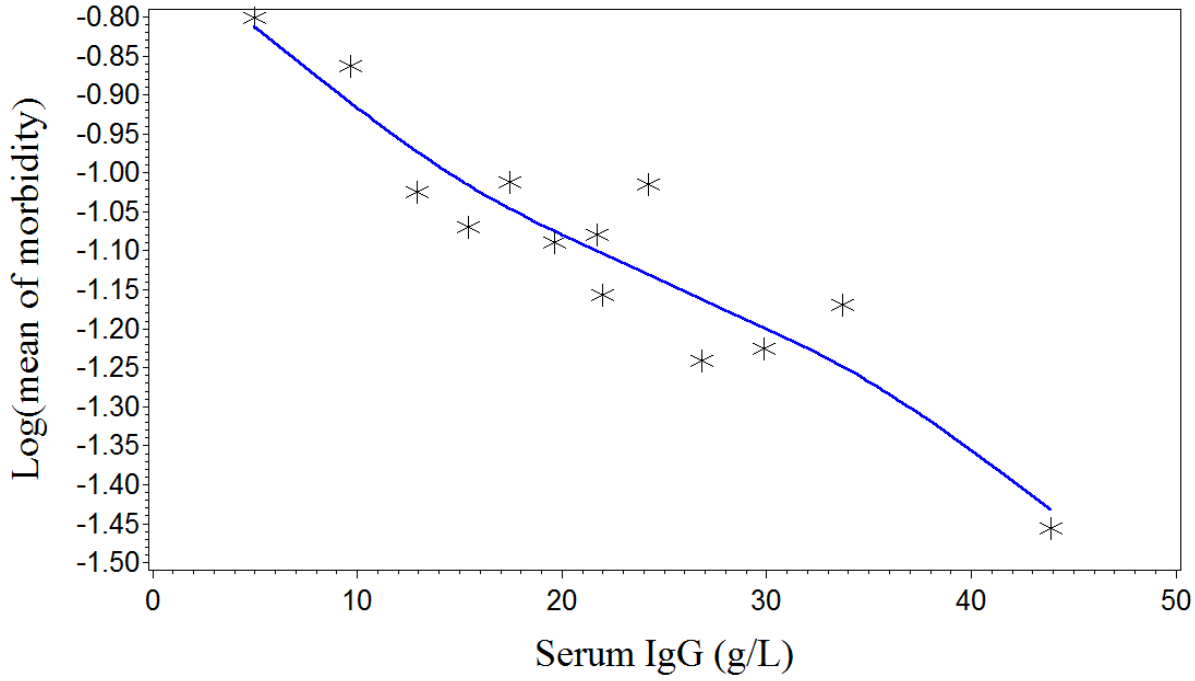

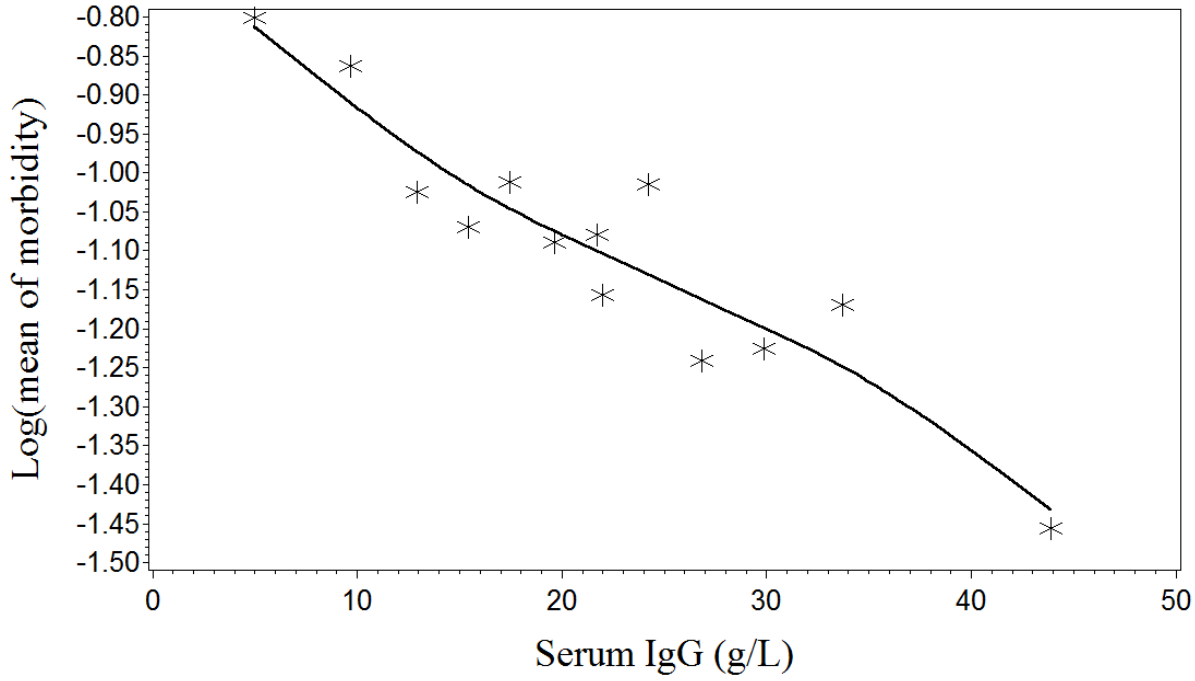

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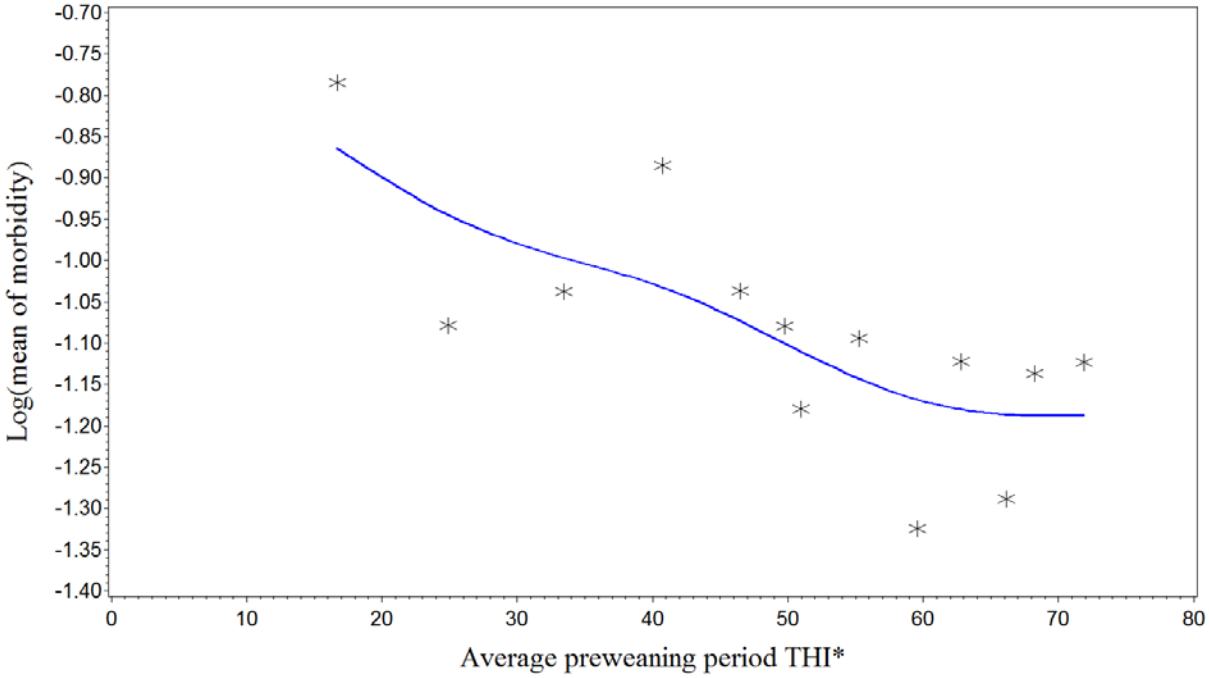

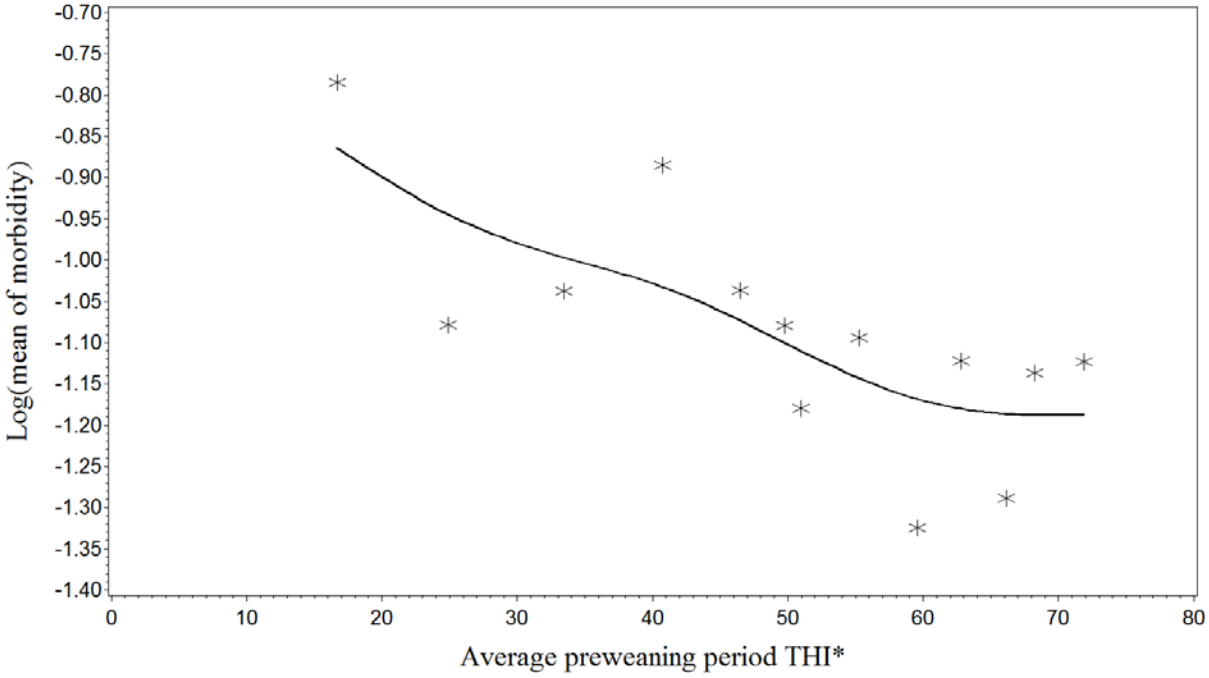

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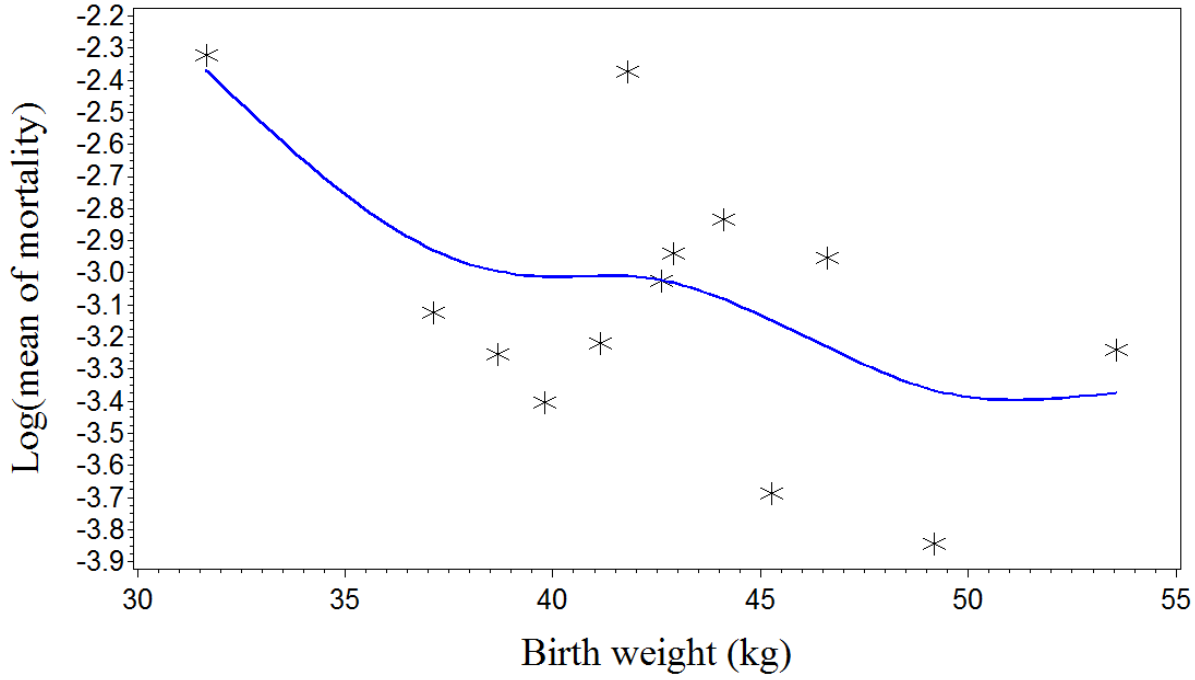
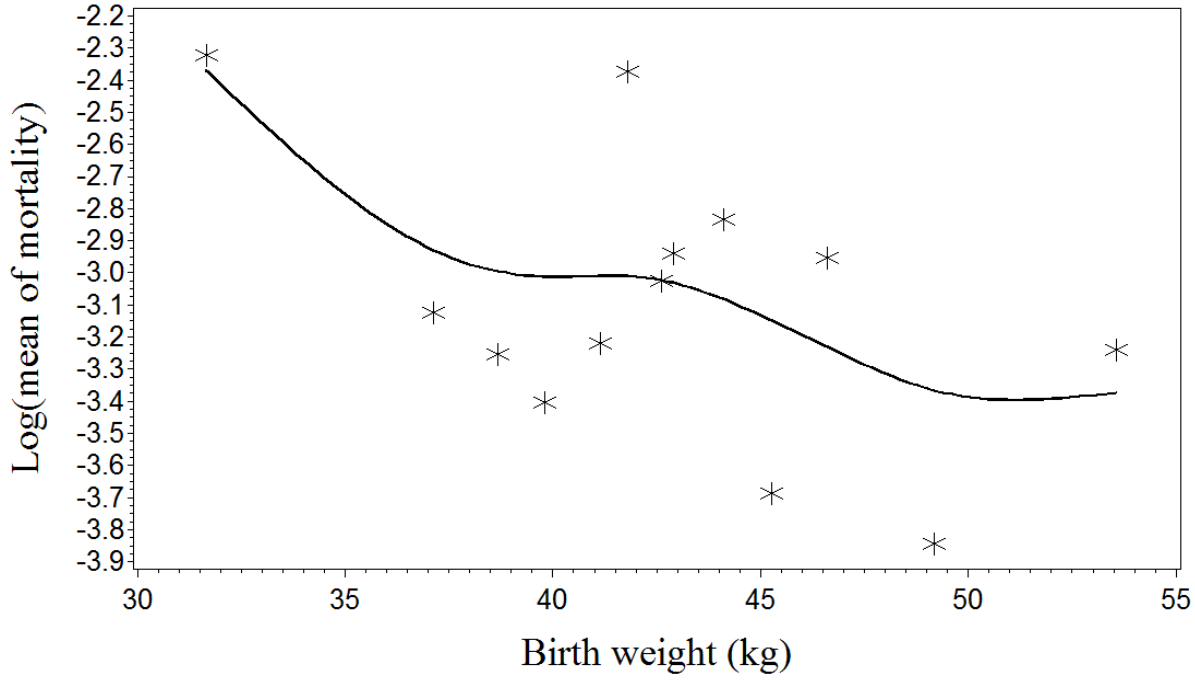
Supplemental Figure S2. Predicted mortality risk for preweaned heifers by (a) birth weight (kg) and (b) serum IgG (g/L) concentration grouped into 12 categories.





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