



ORIGINAL ARTICLE

Potential risk factors associated with ill-thrift in buffalo calves (*Bubalus bubalis*) raised at smallholder farms in Egypt



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ABSTRACT

Failure to grow (ill-thrift) in calves has a negative effect on animal production and health. The present study was carried out from November, 2009 to May, 2013 to investigate the risk factors of ill-thrift in buffalo calves. A total of 344 calves at 78 smallholder farms were selected randomly. A questionnaire was designed to include managerial, nutritional and disease risk factors. Serum selenium, copper, zinc, iron, calcium, phosphorus and magnesium were measured. Data were subjected to logistic regression analysis and results were expressed as p value, odds ratio (OR) and confidence interval (CI). Fifty-five calves (15.9%) showed ill-thrift. On animal level, the final multivariate logistic regression model showed a significant association between ill-thrift and early weaning ($p < 0.01$; OR: 45.755; CI: 4.35–480.25), diarrhea ($p < 0.05$; OR: 41.315; CI: 1.710–998.0), indoor management ($p < 0.05$; OR: 63.56; CI: 2.701–14.96) and low serum phosphorus ($p < 0.01$; 292.0; CI: 5.256–16.23). On farm level, inadequate mineral supplementation ($p < 0.001$; OR: 18.62; CI: 3.89–88.9) and irregular use of anthelmintics ($p < 0.05$; OR: 7.95; CI: 1.53–41.23) were the potential factors. Clinically, ill-thrift calves were more likely to have alopecia ($p < 0.01$), recumbency ($p < 0.01$), emaciation ($p < 0.001$), hypothermia ($p < 0.01$), inappetence ($p < 0.001$), lacrimation ($p < 0.001$), hypomotile rumen ($p < 0.001$), and pale mucous membrane ($p < 0.001$). The results of the present study indicate that ill-thrift in buffalo calves could occur as a result of interaction between management errors and disease factors. Identification of the risk factors associated with ill-thrift may provide useful information, which assist to construct the suitable preventive measures.

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Introduction

Ill-thrift or failure to thrive (FTT) is a common term used in both human and veterinary medicine. In veterinary practice, ill-thrift occurs when calves grow slower than expected on a known amount of feed [1].

In retrospect, the case definition was well described and it is possible that several different diseases were incriminated to cause ill-thrift [2]. Nevertheless, Lambert et al. [3] have attributed the ill-thrift in calves to three main factors; animal, feed and environmental factors. Intestinal parasite [4], fetal infections [5] as well as enteric and respiratory diseases [6] were also implicated to cause this syndrome.

Optimum nutrition and management have beneficial effects on the future productivity in calves, especially in the early pre-weaning period [7]. It has been found that feeding plays an important role in the occurrence of ill-thrift in sheep and cattle [8]. However, poor hygiene control [9], poor housing conditions and other stressors [10] are the main managerial factors. The imperfect immune response has also been included as a risk factor [11].

As more detailed clinical and laboratory examinations of ill-thrift in calves have been done over the years, some of the causes have been identified and characterized by non-specific signs as poor body condition, weakness, and failure to respond to therapy [1]. Such signs adversely affect the future weight gain and productivity with subsequent reduction in the net profit [8].

In the world, the total number of buffalo is 168 million, which represents considerable part of animal wealth. By 2009, the total number of buffalo in Egypt increased up to 4.00 million buffalo; 32% of them are raised in the delta of River Nile at smallholder farms [12]. A limited study on health and growth in buffalo calf in Philippines was conducted [13]. However, to the best of the author's knowledge, there is no available literature on the interaction of different factors which cause failure of weight gain in buffalo calves. Therefore, the objective of the present study was to investigate the nutritional, managerial and disease risk factors associated with ill-thrift in buffalo calves (*Bubalus bubalis*) raised at smallholder farms in Nile Delta region of Egypt.

Material and methods

Study area conduct

This study was accomplished during the period from November, 2009 to May, 2013 at districts of Dakahlia governorate. It lies northeast of Cairo and covers approximately 3.459 km² (N 29° and E 25.48°). It locates on Damietta branch of the River Nile and the Mediterranean Sea coast.

Animals and clinical examination

A total of 344 buffalo calves (*Bubalus bubalis*) at 78 smallholder farms were randomly selected and examined for ill-thrift. *All Institutional and National Guidelines for the care and use of animals were followed.* Firstly, random visits to villages from the basic geographic and administrative units in the Dakahlia governorate were carried out followed by random selection of farms. Selection of location and farms was accomplished using computer software program (Survey toolbox). Selected calves were at 6–12 month of age and 60–150 kg of weight. All calves were proved as normally delivered and had no disease at birth. The feed stuffs available in the areas under investigation were the same. History revealed that there was no evidence of infectious diseases that are causing stillbirth

or chronic weight loss. All calves underwent program of vaccination for infectious diseases including: BVD, Clostridial diseases, FMD, and pasteurellosis. For collecting data on risk factors, a questionnaire was designed with closed questions only. Risk factors incorporated in this study were nutritional, managerial and disease factors. Additional factors related to nutritional status were added based on serum biochemical analysis of examined animals.

Thorough clinical examination of calves was performed according to the method described by Kelly [14]. Calves were considered ill-thrift if their body condition is poor with the following criteria: presence of cavity around the tailhead area, no fatty tissue felt between skin and pelvis with supple skin, ends of transverse processes is sharp to touch and dorsal surfaces can be easily felt, with deep depression in loin. One person evaluated each calf under investigation. In addition, the history of the case implied that the calf did not respond to any treatment. Calves did not follow these criteria were not considered as ill-thrift.

Parasitological examination

Fecal examination was performed to assess the presence of internal parasites. Naked eye examination was carried out to confirm presence of external parasites [14].

Blood samples

Venous blood sample from each animal was collected via jugular vein puncture in a dry, clean and sterile centrifuge tubes without anticoagulant. Only clear, non-hemolyzed serum was transferred into clean tubes for biochemical analysis of Selenium, zinc, copper, iron, calcium, phosphorus, and magnesium.

Biochemical analysis

Biochemical analysis of zinc, copper, calcium, phosphorus, magnesium and iron, were carried out by using commercial test kits (Bio-Diagnostic, Cairo, Egypt) following standard methods mentioned in the leaflet of the manufacturer. Selenium was measured by atomic spectrometry, using a Perkin-Elmer 2380 Atomic Absorption Spectrophotometer Instrument (Norwalk, CT, USA).

Statistical analysis

Analysis of data was performed using statistical software program (SPSS for Windows, Version 16.0, SPSS Inc., USA). Firstly, univariate analysis using chi square test was used to assess the association between the occurrence of ill-thrift and the suggested risk factors on both animal and farm levels. Factors with significant association ($p < 0.05$) were subjected to the multivariate logistic regression analysis. The p value, odds ratio (OR) with a 95% confidence interval (CI 95%), regression coefficient (β) and standard error (SE) were recorded for each variable. For interpretation of the OR, value of OR greater than one indicates that the ill-thrift is more likely to take place than not, while OR less than one indicates that the ill-thrift is less likely to occur than not. A chi-square test was also used to assess the possible association between the ill-thrift and the variables of clinical signs. Chi-square of linear trend was used

when variables had more than two categories. In all statistical analyses, the results were considered to be significant at $p < 0.05$.

Results

Univariate statistics

The present result revealed that 55 (15.98%) out of 344 buffalo calves were showing ill-thrift. On animal level, the distribution of risk factors and the univariate analysis of ill-thrift were summarized in Table 1. Low serum selenium, zinc, copper, iron and phosphorus were the significant nutritional risk factors. However, the management risk factors were colostrum feeding practice, indoor raising, early weaning, and low space allowance. Previous illness, diarrhea, prolonged recumbency, and presence of external parasites had also a significant association.

On the farm level, indoor raising, inadequate mineral supplementation, presence of external parasites, colostrum feeding practice, early weaning, and irregular use of anthelmintics were the risk factors (Table 2).

Multivariate statistics

In multivariable logistic regression model, Hosmer and Lemeshow's goodness of fit test statistic revealed that the model adequately fit the data. On animal level, the final multivariate logistic regression model (Table 3) showed an association between ill-thrift and early weaning ($p < 0.01$; OR: 45.755; CI: 4.35–480.25). Thus, 42 (76.4%) of disease calves were weaned before 30 days of life. Diarrheic calves were more likely to be ill-thrift ($p < 0.05$; OR: 41.315; CI: 1.710–998.0), where 44 (80%) of ill-thrift calves were suffering from diarrhea for long period. Ill-thrift was also associated with indoor management ($p < 0.05$; OR: 63.56; CI: 2.701–14.96). So, 48 (87.3%) of ill-thrift calves were raised indoor ($p < 0.01$; OR: 292.0; CI: 5.256–16.23). Low serum phosphorus significantly influenced the occurrence of ill-thrift. Fifty-three calves with ill-thrift were having low serum phosphorus.

On the farm level, inadequate mineral supplementation ($p < 0.001$; OR: 18.62; CI: 3.89–88.9) and irregular use of anthelmintics ($p < 0.05$; OR: 7.95; CI: 1.53–41.23) were the potential factors (Table 4).

Association between ill-thrift and clinical signs

Ill-thrift calves were more likely to show alopecia ($p < 0.01$; OR: 14.6; CI: 3.7–56.6), recumbency ($p < 0.01$; OR: 8.3; CI: 2.1–31.7), emaciation ($p < 0.001$; OR: 34.7; CI: 34–353.2), hypothermia ($p < 0.01$; OR: 8; CI: 3.78–85.6), Inappetance ($p < 0.001$; OR: 12.33; CI: 3.2–47.39), lacrimation ($p < 0.001$; OR: 24.83; CI: 1.42–42.2), rapid respiratory rate ($p < 0.0001$; OR: 156; CI: 61.1–399), weak rapid pulse ($p < 0.0001$; OR: 156; CI: 61.1–399), hypomotile rumen ($p < 0.0001$; OR: 16.63; CI: 5.0–78.9), and pale mucous membrane ($p < 0.001$; OR: 69.9; CI: 12.9–37.9).

Discussion

In production animals, ill-thrift or weight faltering can be a prelude to significant losses but without definite etiology [1].

Several reports have addressed the disease conditions causing ill-thrift in animals [3,7], but buffalo calves were not included. In the present study, an overview on the interaction between managerial, nutritional and disease risk factors associated with ill-thrift was obtained. Based on the final multiple logistic regression model, early weaning, diarrhea, indoor raising and low serum phosphorus were the potential risk factors on the animal level.

Weaning before 30 days of animal life increased the prevalence of ill-thrift significantly, where 76.4% of ill-thrift calves were weaned before one month of age. Early weaning may subject the calves to nutritional deficiency and render them more liable to digestive disturbances caused by feeding on milk substitutes. Furthermore, it is common behavior among small-holder farmers in Egypt to withhold colostrum intake partially at early life of calves. The above mentioned errors may interfere with the passive immune response via colostrum deprivation, nutritional deficiency with subsequent liability to diarrhea and infection. Barrington et al. [15] reported that passively acquired immunity through colostrum is a major risk factor of diarrhea and other infections [16–18]. On the contrary, colostrum leukocytes without humoral components of the colostrum were not able to prevent fatal losses in the calves due to natural infection, although their influence on immune responses of the calves was evident *in vitro* [17]. Moreover, early weaning and introduce of another diet may deprive calves from essential nutrients and trace elements. This postulation is in concern with that reported by Davies [19]. Contributing factors other than early weaning have also been found to render the calves unable to take sufficient milk intake [5,20].

Diarrhea can result in ill-thrift via different mechanisms including nutritional errors, imperfect nutrient absorption, and/or faulty digestion, absorption and metabolism [17,21]. In the present study, 80% of the ill-thrift calves had a history of diarrhea, which might be induced by multifactorial causes [18,22,23]. Unfortunately, in the present study, presence of internal parasites was the only examined cause of diarrhea.

External parasites infestation, but not internal parasites, was a potential factor causing ill-thrift, where 87.2% and 18.2% of ill-thrift calves had external and internal parasites, respectively. Therefore, it is suggested that parasitic infestation may lead to ill-thrift either via subjecting calves to diarrhea, nutrition deprivation, and discomfort. Our explanation is supported by several studies, which showed that diarrhea is a main clinical finding of parasitic infestation in buffalo calves [18,23]. In the examined calves, there was poor parasitic control, where 60% of ill-thrift calves did not receive treatment for parasites. In the studied farms, there was no strategy for regular use of anthelmintics. This finding is in agreement with Litherland [24] who reported that 45% of ill-thrift cases was attributed to parasitic infestation. On the other hand, other infections causing diarrhea cannot be ruled out as a risk factors.

Indoor raising has several deleterious effects, which may lead to ill-thrift. These effects include: abrasive floor [25] and joint affections [21]. Due to high stocking rate, indoor management may also facilitate transmission of internal and protozoan parasites [23,26] with subsequent occurrence of diarrhea, and nutritional deficiency. The present results showed that 48 (87.3%) of ill-thrift calves were raised indoor, of them 20 were raised on concrete. This finding suggests that indoor management may have interrelating factors cause ill-thrift.

Table 1 Categorization of buffalo calves as ill-thrift or normal with respect to different risk factors.

Variable and category	Ill-thrift (<i>n</i> = 55)	Normal (289)	<i>p</i>	OR	CI
<i>Gender</i>					
Female = 1	34	180	1.0000	0.9804	0.541–1.776
Male = 2	21	109			
<i>Indoor raising</i>					
No = 0	7	202	0.0001	0.06281	0.02–0.144
Yes = 1	48	87			
<i>Presence of external parasites</i>					
Yes = 1	48	67	0.0001	22.72	9.81–52.57
No = 0	7	222			
<i>Floor</i>					
Ground = 0	35	219	0.0669	0.5594	0.303–1.031
Concrete = 1	20	70			
<i>Colostrum feeding practice</i>					
Yes = 1	31	40	0.0001	8.364	4.461–15.68
No = 0	24	259			
<i>Early weaning</i>					
Yes = 1	42	34	0.0001	24.23	11.82 - 49.67
No = 0	13	255			
<i>Regular use of anthelmintics</i>					
Yes = 1	12	230	0.0001	0.07159	0.035–0.144
No = 0	43	59			
<i>Presence of internal parasites</i>					
No = 0	10	258	0.0001	0.02670	0.01–0.058
Yes = 1	45	31			
<i>Space allowance</i>					
Sufficient = 1	26	229	0.0001	0.2349	0.12–0.42
Not sufficient = 0	29	60			
<i>Diarrhea</i>					
Yes = 1	44	29	0.0001	37.24	17.3–79.9
No = 0	11	270			
<i>Previous illness</i>					
Yes = 1	49	5	0.0001	463.9	136.2–1579
No = 0	6	284			
<i>Low serum Selenium ($\mu\text{g}/\text{dl}$) (<1.0)</i>					
Yes = 1	47	40	0.0001	41.29	18.0–94.42
No = 0	8	249			
<i>Low serum Zinc ($\mu\text{g}/\text{dl}$) (<175)</i>					
Yes = 1	53	36	0.001	186.2	43.4–97.7
No = 0	2	253			
<i>Low serum Copper ($\mu\text{mol}/\text{l}$) (<17)</i>					
Yes = 1	50	31	0.001	83.23	30.8–224.5
No = 0	5	258			
<i>Low serum Iron ($\mu\text{mol}/\text{l}$) (<57)</i>					
Yes = 1	54	38	0.0001	356.7	47.9–65.1
No = 0	1	251			
<i>Low serum calcium (mg/dl) (<11)</i>					
Yes = 1	49	30	0.001	70.51	27.8–78.4
No = 0	6	259			
<i>Low serum Phosphorus (mg/dl) (<5)</i>					
Yes = 1	53	65	0.001	91.32	21.6–38.0
No = 0	2	224			
<i>Low serum Magnesium (mg/dl) (<2.5)</i>					
Yes = 1	54	80	0.001	141.1	19.1–103
No = 0	1	209			

OR = Odds ratio; CI = Confidence interval at 95%.

Table 2 Farm level categorization of buffalo calves as ill-thrift or normal in respect to different risk factors.

Variable and category	Ill-thrift (<i>n</i> = 48)	Normal (<i>n</i> = 30)	<i>p</i>	OR	CI
<i>Indoor raising</i>					
No = 0	3	20	0.001	0.033	0.008–0.13
Yes = 1	45	10			
<i>Inadequate mineral supplementation</i>					
No = 0			0.0001	55.0	13.5–223
Yes = 1	4	25			
	44	5			
<i>Presence of external parasites</i>					
Yes = 1	44	7	0.0001	0.027	0.007–0.10
No = 0	4	23			
<i>Floor</i>					
Ground = 1	29	20	0.6360	0.7632	0.29–1.982
Concrete = 0	19	10			
<i>Colostrum feeding practice</i>					
Yes = 1	24	5	0.01	5.0	1.64–15.24
No = 0	24	25			
<i>Early weaning</i>					
Yes = 1	30	3	0.0001	15.88	4.18– 60.2
No = 0	18	27			
<i>Irregular use of anthelmintics</i>					
Yes = 1	10	27	0.01	0.029	0.007–0.11
No = 0	38	3			
<i>Sufficient space allowance</i>					
Yes = 1	20	26	0.01	0.1099	0.03– 0.36
No = 0	28	4			

OR = Odds ratio.

CI = Confidence interval at 95%.

Table 3 Final logistic regression model for potential risk factors associated with ill-thrift in buffalo calves on animal level.

Variable	β	SE	Wald	P	OR	CI
Early weaning	3.82	1.200	11.98	0.001	45.755	4.35–48.25
Diarrhea	3.721	1.625	8.21	0.022	41.315	1.710–99.0
Indoor management	4.152	1.612	9.77	0.010	63.56	2.701–14.96
Low serum phosphorus	5.677	2.050	13.10	0.006	29.0	5.256–16.23
Constant	–2.678	1.366	4.21	0.050	0.069	–

 β = Régression coefficient.

SE = Standard error.

OR = Odds ratio.

CI = Confidence interval at 95%.

The percentages of potential risk factors in buffalo calves with ill-thrift was: Early weaning (76.3%); Diarrhea (80%); Indoor management (87.2%); Low serum phosphorus (96.3%).

Low serum phosphorus was found as a potent risk factor of ill-thrift in buffalo calves. Thus, 96.3% of ill-thrift cases had phosphorus deficiency. Although other measured major or minor elements did not show a significant association with ill-thrift, we cannot rule out their role in the occurrence of such syndrome. Phosphorus deficiency was consistent in 96.3% of calves as the feeding regimen depends mainly on feeding of barseem (*Trifolium alexandrinum*), which is deficient in phosphorus. Failure of the owners to compensate such deficiency could precipitate the state of phosphorus deficiency. This result is supported by results of experimental study conducted by

Blair-West et al. [27] who found that phosphorus deficiency results in failure of weight gain and maintenance of body condition. In sheep, ill-thrift is attributed to nutritional deficiency when the animal managed in mineral deficient pasture [28].

On farm levels, inadequate mineral supplementation and irregular use of anthelmintics were the potential risks. 91.6% of the farms with ill-thrift calves had inappropriate mineral supplementation, but 79.1% had no regimen for parasite control. The association between inadequate mineral supplementation with ill-thrift supports the above mentioned result of

Table 4 Final logistic regression model for potential risk factors associated with ill-thrift in buffalo calves on farm level.

Variable	β	SE	Wald	P	OR	CI
Inadequate mineral supplementation	2.9	0.79	31.20	0.000	18.62	3.89–88.9
Irregular use of anthelmintics	2.73	0.84	18.3	0.014	7.95	1.53–41.23
Constant	–2.07	0.57	5.39	0.000	0.125	–

β = Régression coefficient.

SE = Standard error.

OR = Odds ratio.

CI = Confidence interval at 95%.

The percentage of potential risk factors in farms with ill-thrift calves was: Inadequate mineral supplementation (91.6%); irregular use of anthelmintics (79.1%).

low serum phosphorus. Trace mineral deficiency received special attention as a real cause of calf health problems [1]. Although the final logistic regression model did not include trace minerals, we cannot neglect their role in present problem. Placental transfer of trace minerals and colostrum trace mineral concentrations affect on trace element status in newborn calves and consequently on the health status [29]. Based on a retrospective study, copper, zinc or Selenium deficiency have been found the main risk factors for one or more calf health disorders (perinatal mortality, diarrhea, vaccination failure, myopathy, or heart failure) [30]. In present results, serum trace minerals level was not included in the final logistic regression model, but their implication in univariate analysis may reflect their importance in calf health. Generally, trace minerals are a cofactor of several metalloenzymes and other metalloproteins and antioxidant enzymes [31]. In addition, deficiency of some trace elements not only cause clinical disease, but also affect on absorption of other elements [1].

Farms did not use anthelmintics regularly had higher prevalence of ill-thrift, where 38 (79.16%) of such farms have ill-thrift calves. It has been established that use of anthelmintics can eliminate both external and internal parasites, which cause ill-thrift by different mechanisms [1].

Clinically, the signs of significant association with ill-thrift reflected the worse state of calves. The clinical findings in our study suggest that failure to thrive can preface to significant morbidity and mortality in buffalo calves, especially in poorly managed calves, and in calves with various chronic illnesses. As previously reported, calves and sheep with ill-thrift usually have non-specific findings and sometimes signs of specific etiology may present [1,30]. Although the affected calves were vaccinated against the most common infectious diseases, infection with such diseases cannot be ruled out. Detection of the infectious diseases or other diseases incriminated to cause ill-thrift may have time and economic impacts. Therefore, clinical finding may have diagnostic and prognostic significance when confronted cases with ill-thrift.

Surprisingly, in the present study, exposure of buffalo calves to respiratory diseases was not implicated as a risk factor in spite of established association between respiratory diseases and occurrence ill-thrift in cattle calves and sheep [32,33]. The reason for exclusion of this factor was that all ill-thrift buffalo calves were not showing or having a history of respiratory distress. This finding does not rule out the role of respiratory disease as risk for ill-thrift in buffalo calves. The limitations of the present study include the following: the small sample size, limited number of risk factors and use of narrow

geographic areas of Egypt. Thus, implications of these issues in further studies could be substantial to explore more risks.

Conclusions

As a first report, the present study provides preliminary information about the risk factors associated with ill-thrift in buffalo calves in Delta region of Egypt. Managemental and nutritional factors are the main risks of such syndrome. Further studies need to be done on large sample size and wide range of risk factors, as identification of these risk factors may be of use for veterinarians and herders to set up the correct preventive measures of ill-thrift in the population of buffalo calves.

Conflict of interest

The authors have declared no conflict of interest.

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