

Oxidative Stress Biomarkers in Dystrophic Lambs and Kids in Relation to Body Condition Scores

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Abstract

This study was conducted to investigate the relationship between the severity of muscular dystrophy, caused by vitamin E and selenium deficiencies in lambs and kids, and their body condition score (BCS). A total of 71 lambs and kids aged from 1-6 months were used; 51 dystrophic animals (38 lambs and 13 kids) and 20 healthy ones (10 lambs and 10 kids). The animal grouping was done on the basis of BCS and the obtained hematological and biochemical alterations. Blood samples were collected after clinical examination to all animals, for performing the clinicopathological studies. Results showed that the incidence and severity of the disease were higher in rapidly growing and well-nourished lamb (BCS 3.5-4), while the occurrence of the disease in kids was more common in BCS 1-2.5. Regarding biochemical findings, the serum vitamin E, Se, CAT and GSH-Px recorded lower values in dystrophic lambs and kids than the control, while higher values of CPK, CTn I, MDA and NO were recorded with the strongest alterations in good bodily conditioned ones. A significant decrease in serum Mg level in dystrophic kids with BCS 1-3 was also observed. In conclusion, proper nutrition of dam and young without shortage or excess is necessary. Also, vitamin E and se supplementation should be increased in good bodily conditioned and rapidly growing animals than their counterparts to activate the antioxidant system and reduce oxidative stress.

Keywords: BCS, Lambs, Kids, Vitamin E deficiency, Oxidative stress

Introduction:

Economically, sheep and goats are considered one of the most important livestock in Egypt. They can be raised by the poor farmer because they are relatively cheaper than other livestock and have short lambing and kidding interval with a high incidence of twins, sometimes triples [1]. On the nutritional side, sheep and goats are considered sweeper animals because they graze the crop residues after harvest. In spite the last benefit, proper nutrition should be applied to avoid nutritional deficiency diseases. Vitamin E and Selenium (Se) deficiency named stiff –lamb disease (SLD) or nutritional muscular dystrophy (NMD) considered one of the most important nutritional deficiency diseases affect small ruminants [2,3]. Vitamin E (α -tocopherol) is a major lipid-soluble antioxidant vitamin and selenium (Se) is a cofactor for glutathione peroxidase (GSH-Px) enzyme [4,5] which together act as a biological antioxidant that eliminates the reactive oxygen species (ROS)

and prevents the cellular oxidative damage resulted from membrane lipid peroxidation [6].

NMD has different condition such as white muscle disease (WMD) or also known as stiff–lamb disease that occur in lambs up to 3 months of age, congenital WMD in newborn lambs which may dead recently or shortly after birth, delayed WMD occurs in lambs of 1-3 months of age which affect limbs, weaned ill thrift which characterized by poor growth rates and decreased wool production, Se- responsive scouring and finally ewe infertility [7].

Scott [8] mentioned that nutritional muscular dystrophy typically affects rapidly growing 2-6 wks old lambs, the disease characterized by sudden onset of stiffness, reluctant to move as they are easily caught while others in the group gallop around, lambs are bright, alert and suckle well but have a painful expression with the head held lowered. One or two days later, affected lambs are

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unable to rise and remain in the sternal recumbency.

Ghanem *et al.* [9] stated that the most observed signs of muscular dystrophy in lamb were ill-thriftiness, weakness, depression, stiffness in gait, knuckling at fetlock joint, sternal recumbency, inability to stand, trembling if the animal forced to stand, while the changes in the vital signs were dyspnea, tachycardia, and irregular heart beat "arrhythmia".

Hence the occurrence of muscular dystrophy was considered with rapidly growing animals, we noticed that if twin lamb or goat kid under the same condition develops muscular dystrophy, the symptoms were aggravated in good bodily conditioned one.

Body condition scoring is a simple method for evaluating the performance of an animal, it can be easily applied clinically and it can be used for all ages of animals. Routine BCS is important for evaluating the current and past feeding program; it can help to detect any potential problem that might cause a serious problem, especially those related to the nutrition. A body condition scoring system for sheep and goats were recognized according to Pennington [10] and Koyuncu and Altınçekiç, [11] it ranges from 1 to 5, score of 1 is very thin or emaciated animal and middle point is 3 while score of 5 is a very fat or obese animal, healthy and good nourished animal should not be very fat or very thin.

Both vitamin E and Se deficiency in lambs and kids based on its BCS are poorly studied so, the present study was established to clarify the relationship between the severity of signs in the dystrophic animals and their BCS.

Material and methods

Ethical approval

The protocol of our study was approved by the Ethics Committee of Egyptian Veterinary Medicine Authority.

Animals grouping

This study started when twin's lambs exhibited signs of muscular dystrophy. Signs were more severe in the good bodily condition one. This study was conducted on 71 lambs

and kids; 51 dystrophic animals within 1 to 6 months of age. Animals were admitted to Veterinary Medical Teaching Hospital, Faculty of Veterinary Medicine, Zagazig University, Egypt. The main owner's complaints were stiffness in gait, inability to stand and prefer recumbency.

Animals grouping was done according to BCS; control groups contain 10 lambs (BCS 2.5-4) and 10 kids (BCS 2-3.5), while 38 dystrophic lambs were used with BCS 1-2 (10 case, 26.32%), BCS 2-3 (6 case, 15.78%), BCS 3-3.5 (15 case, 39.47%) and BCS 3.5-4 (7 case, 18.42%). The dystrophic kids were 13, of which 6 cases (46.16%) with BCS 1-2, 5 cases (38.46%) with BCS 2-3 and two cases (15.38%) only with BCS 3&3.5.

Management and Feeding regime

Diseased animals either came from small private farms with proper feeding regime, grains, hay and green pasture or from the flocks reared by stockmen where the nutrition of the dam and young animals depends mainly on bad quality hay, remnants of root crops, rice straw *ad libitum* and rarely barseem. While control ones were belonged to the Animal Production Farm of Faculty of Veterinary Medicine, Zagazig University and they fed a balanced ration, barseem was utilized when available.

Clinical examination

Clinical examination of all animals was performed; history regarding age, location, feeding regime and observed signs were taken. Physical examination was done, and vital signs were monitored according to Sherman and Robinson [12].

A condition scoring system was then applied to facilitate the comparison among animals. The body condition scoring system was based on visual appraisal and palpation, the condition was evaluated on a scale of 1 to 5, with 1 being extremely emaciated and 5 being extremely fat. A description of the condition score system was done according to ESGPIP and Technical Bulletin No. 8 [13], the scoring was based on manual palpation of the loin region (located behind the last rib and before the hip bones) in which the degree of

bony prominence as spinous process and transverse process of lumbar vertebrae can be measured, the second region is the thoracic cavity, ribs, and sternum.

Blood sampling

For hematological analysis, 2 mL of blood was collected from the jugular vein of all dystrophic and control animals in tubes with di-potassium salt of ethylene-di-amine-tetra-acetic acid (EDTA), and another 5 mL was obtained in a plane tube (without EDTA), allowed to coagulate at sloped manner for 30 min and centrifuged at 3,000 rpm for 10 min to separate good and clear straw yellow serum. The obtained serum was stored at -20°C until used for estimation of selective biochemical parameters.

Hematological studies

In aliquot EDTA-blood, red blood cells (RBCs) count, hemoglobin (Hb) concentration, packed cell volume (PCV), mean corpuscular volume (MCV), mean corpuscular hemoglobin concentration (MCHC) were estimated using full version automatic cell counter (Sysmex KX-21N, Japan) according to the method of Grindem [14].

Biochemical analysis

Serum vitamin E and Se were measured at the Central Lab. of Veterinary Medicine Collage, Zagazig University, Egypt using high-performance liquid chromatography according to Chawla and Kaur [15] and atomic absorption spectrophotometer as described by Sunderman and Roszel [16] respectively. The other biochemical parameters were estimated following the methods described at the enclosed pamphlets of manufacturer's kits for magnesium, Mg [17]; creatine phosphokinase, CPK [18]; cardiac troponin 1, CTn1 [19]; malondialdehyde, MDA [20]; catalase, CAT [21]; glutathione peroxidase, GSH-Px [22] and Nitric oxide, NO [23].

Statistical Analysis

Data were statistically analyzed by statistical software program (SPSS, version 16) using One Way ANOVAF-test to compare between the dystrophic animals and control one. Mean values \pm SE for each parameter was

estimated. Results were considered statistically significant at $P < 0.05$ [24].

Medical intervention

Affected animals usually respond to vitamin E and selenium injection within few days and able to stand and walk, except one lamb with BCS 4 and 1 kids with BCS 1 as their case was deteriorated.

Results

Clinical observation

The most important predisposing factor for stiff lamb disease is unaccustomed exercise, wondering after weaning, the driving of flocks with new lamb and kids long distances. In the same context, kids with hypomagnesemia consider a contributing factor.

Regarding BCS, firstly it is clear that fat deposition in sheep and goat was differed, sheep have more subcutaneous and intramuscular fat, in contrast, and goats have more internal fat. BCS of 1.0 is an extremely thin goat with no fat reserves and a BCS of 5.0 is a very over-conditioned and it is never observed in our study. In our study, healthy kids have BCS of 2.5 to 3.5; meanwhile BCS of 1.0, 1.5, or 2.0 indicate a management or health problem and BCS of 4, 4.5 or 5 was almost never observed in kids under normal management conditions. Healthy lambs usually have BCS 3-4 and BCS under 3 indicates a health problem. Concerning the occurrence of the disease in relation to BCS, the disease was common in lamb with good body condition (BCS 3-4), also it occurs frequently in ill-thrift kids with poor body condition (BCS 1-2).

Clinical findings were summarized in Table 1, Most of the affected animals remain alert with normal appetite, but in severe cases that occur mostly in BCS 4 in lambs and BCS 1-2 in kids, the appetite and alertness may be affected. Symptoms vary from stiffness in gait, to inability to stand and when an attempt was made to help the animal to stand, it mostly trembles with pain, stands on tip-toe and prefers recumbency (Figures 1, 2). Lamb and

kids usually show cardiopulmonary signs including tachycardia (heart rate equal 120-190/min), tachyarrhythmias, tachypnea (respiration rate up to 48-65/min), dyspnea and wholly abdominal type of respiration while body temperature is usually normal or slightly elevated. Palpation of the affected muscles (shoulder, gluteal and thigh muscle) showed bilateral symmetrical swollen, softness and pain especially in animals with good body

condition. While in BCS1-2 the muscles usually atrophied and firm. Of kids, two showed signs of hypomagnesaemia, kids initially show ataxia, stiffness, and hyperexcitability and hyperesthesia to touch, and fall in the ground with paddling, convulsion, and opisthotonus position, by the end of the fits, animal stand and walk on the tip toe and appear on pain.

Table 1: Clinical findings in dystrophic lamb and kids

Parameters	Clinical Findings	Lambs (38)		Kids (13)	
		No.	%	No.	%
Alertness	and Alert with normal appetite	28	73.68	8	61.53
Appetite	Alert but need help to eat	8	21.05	4	30.76
	Depressed with anorexia	2	5.26	1	7.69
Posture	Stand with back humped and the limb under the body.	13	34.21	5	38.46
	Sternal recumbency and unable to stand.	25	65.78	8	61.53
	Make an attempt to stand and stand with trembling.	20	52.63	8	61.53
	Standing on tip-toe	36	94.73	13	100
	Lateral recumbency with consciousness	2	5.26	0	0
Gait	Reluctant to move	30	78.94	13	100
	Stiffness in gait	30	78.94	13	100
	Walking in the tip toe	36	94.73	13	100
	knuckling at the fetlocks	7	18.42	5	38.46
	Elevation of the two scapulae above the level of back and attach each other during walking.	32	84.21	9	69.23
Vital signs alterations**	Pulse Tachycardia	31	81.57	13	100
	Tachyarrhythmias	7	18.42	0	0
	Resp. Tachypnoea	38	100	13	100
	Dyspnoea and labored respiration	25	65.78	9	69.23
	Wholly abdominal respiration	25	65.78	9	69.23
	Temp. Normal temperature	30	78.94	11	84.61
Slightly elevated temperature	8	21.05	2	15.38	
Color of mucous membrane	Light rose	33	86.84	6	46.15
	Pale	5	13.15	6	46.15
Palpation of muscle	Slightly congested	0	0	1	7.69
Other alterations	Bilateral symmetrical enlargement and softness	29	76.31	2	15.38
	Atrophied and firm	9	23.68	11	84.61
	Ill –thrift with additional signs of hypomagnesemia.	4	10.52	11	84.61
	signs of copper deficiency.	0	0	3	23.0
	signs of iron deficiency	8	21.05	8	61.53

**In the control group (lamb and kids respectively), Pulse rates were 80.67 ± 2.8 and 82.66 ± 3.15 /min, Respiration rates were 20.8 ± 0.058 and 21.4 ± 0.46 /min and temperature were 39.4 ± 0.08 and 39.5 ± 0.05 C.



Figure 1: Lambs with different BCS, showing typical signs of stiff- lamb disease; walk in tip-toe (a), prefer recumbency (b), stand on tip-toe (c, f), sternal recumbency (d) and lateral recumbency with tachypnoea and mouth breathing (e).

Hematological findings

As localized in Table (2) compared to control group, the dystrophic lambs and kids in different body condition scores showed a significant ($P \leq 0.05$) decrease in the values of

RBCs, Hb, PCV and MCHC and significant increase ($P \leq 0.05$) in MCV. The severity of anemia was higher in ill thrift animals with decreased condition than those in good body condition (BCS 3-4 in lamb and 3-3.5 in kids).

Table 2: Erythrogram of dystrophic lambs and kids compared to their control

	BCS	RBCS ($\times 10^6/\mu\text{l}$)	Hb (g/dl)	PCV (%)	MCV (fl)	MCHC (%)
Lambs						
Control	3-3.5	8.36 \pm 0.08 ^a	14.80 \pm 0.11 ^a	44.80 \pm 0.13 ^a	53.55 \pm 0.43 ^c	33.03 \pm 0.17 ^a
NMD	1-3	5.46 \pm 0.48 ^c	10.66 \pm 0.83 ^c	35.60 \pm 2.30 ^c	65.20 \pm 3.17 ^a	29.94 \pm 0.74 ^b
	3-4	6.73 \pm 0.09 ^b	12.00 \pm 0.12 ^b	40.10 \pm 0.20 ^b	59.83 \pm 0.59 ^b	29.92 \pm 0.14 ^b
	Sig.	**	**	**	*	*
Kids						
Control	3-3.5	7.40 \pm 0.05 ^a	14.20 \pm 0.11 ^a	40.46 \pm 0.29 ^a	54.69 \pm 0.81 ^c	35.08 \pm 0.04 ^a
NMD	1-2.5	4.75 \pm 0.13 ^b	10.50 \pm 0.17 ^b	32.00 \pm 0.57 ^b	67.36 \pm 1.43 ^a	32.81 \pm 0.11 ^b
	2.5-3.5	5.96 \pm 0.03 ^b	11.26 \pm 0.11 ^b	35.33 \pm 0.17 ^b	59.27 \pm 0.84 ^b	31.87 \pm 0.59 ^b
	Sig.	*	*	*	*	*

-Body Condition Scoring; BCS, Nutritional Muscle Dystrophy; NMD, Red Blood Cells; RBCs, Hemoglobin; Hb, Packed Cell Volume; PCV, Mean Corpuscular Volume; MCV, Mean Corpuscular Hemoglobin Concentration; MCHC. All data having different letters are differ significantly at $p < 0.05$.



Figure 2: kids with BCS 1-3.5; knuckling on the fetlock with multiple deficiency signs (a), unable to stand (b, c, and d), twin kids; with help, stand on tip-toe (e) and arching the back, suffering from pain (f).

Biochemical results

Table (3) showed a significant ($P \leq 0.05$) decrease in the serum levels of vitamin E, Se, CAT, GSH-Px with a significant ($P \leq 0.05$) increase in the values of CPK, CTn1, MDA and NO besides non-significant changes in serum Mg level in dystrophic lambs when compared to the control group. These findings

were higher in lambs with BCS 3-4 than those of 1-3. While in dystrophic kids, they showed a significant ($P \leq 0.05$) decrease in the serum levels of vitamin E, Se, Mg, CAT, GSH-Px with a significant ($P \leq 0.05$) increase in the values of CPK, CTn1, MDA and NO, but with the same degree of severity in BCS 1-2.5 and 2.5-3.

Table 3: Serum biochemical parameters in dystrophic lambs and kids compared to normal animals

	BCS	Vit. E (µg/ml)	Se (µg/ml)	Mg (mg/dl)	CPK (U/L)	CTn1 (ng/ml)	MDA (nmol/ml)	CAT (U/L)	GSH-Px (U/L)	NO (µmol/L)
Lambs										
Control	3-3.5	1.06±0.11 ^a	0.160±0.013 ^a	2.44±0.18	52.80±1.85 ^c	0.006±0.001 ^c	2.50±0.20 ^c	214.40±6.98 ^a	29.80±0.66 ^a	3.04±0.22 ^c
NMD	1-3	0.49±0.06 ^b	0.070±0.010 ^b	2.16±0.31	790±106.95 ^b	5.142±1.232 ^a	6.30±0.40 ^b	149.60±11.04 ^b	13.40±1.21 ^b	8.40±0.42 ^b
	3-4	0.20±0.02 ^c	0.008±0.001 ^c	2.44±0.14	964±89.92 ^a	4.660±0.778 ^b	8.32±0.31 ^a	130.60±3.22 ^b	9.00±0.71 ^c	9.88±0.55 ^a
Sig.		**	**	NS	**	**	**	*	**	**
Kids										
Control	3-3.5	0.95±0.05 ^a	0.200±0.011 ^a	2.34±0.12 ^a	50.60±1.08 ^b	0.007±0.002 ^b	3.10±0.26 ^b	217.60±7.43 ^a	32.20±1.16 ^a	2.72±0.20 ^b
NMD	1-2.5	0.31±0.03 ^b	0.015±0.004 ^c	1.28±0.25 ^b	896±89.92 ^a	3.78±0.882 ^a	7.44±0.58 ^a	156.80±10.74 ^b	8.60±0.93 ^b	9.08±0.43 ^a
	2.5-3.5	0.20±0.03 ^b	0.082±0.009 ^b	1.70±0.30 ^{ab}	814±82.74 ^a	2.680±0.292 ^a	8.28±0.32 ^a	153.80±9.67 ^b	11.00±0.71 ^b	8.42±0.30 ^a
Sig.		*	**	*	*	*	*	*	*	*

- All data having different letters are differ significantly at p < 0.05.N.S; Non significant.

-Body Condition Scoring; BCS, Nutritional Muscle Dystrophy; NMD, Selenium; Se, Magnesium; Mg, Creatine Phosphokinase; CPK, Cardiac Troponin 1; CTn1, Malondialdehyde; MDA, Catalase; CAT, glutathione peroxidase; GSH-Px, Nitric oxide; NO

Discussion

In the present study 38 of 51 (74.5%) dystrophic animals were lambs, while kids resemble 25.4%, this may be owed to the tendency of the owner in the study localities to breed sheep more than goats.

Sudden unaccustomed exercise as a predisposing cause for muscular dystrophy may be explained under the following base, high muscle activity causes a strong increase in ROS production which contains oxygen and are extremely reactive due to an unpaired electron. Among these oxygen, intermediates are the free radicals superoxide, peroxide and the hydroxyl radicals. They promote oxidation reactions with proteins, lipids, and DNA and can thus be highly detrimental, but the seeking for another factor than low selenium and vitamin E might be involved, as many field veterinarians suggested that metabolic stresses together with selenium and/or vitamin E deficiency are necessary for the clinical disease to occur [25].

Let us first agree that rapid growth is accompanied by increased metabolic rate, and thus oxygen consumption, as the growth is highly physiologically demanding. Therefore, the rapidly growing animal may be exposed to relatively more ROS which may impair the physiological functions in the body and reduce survival and fitness [26, 27]. In rapidly growing lamb, oxidative stress increases, high MDA levels appeared to be related to faster growth but have little impact on subsequent survival, so, the associations between oxidative stress markers, growth and survival are highly marker and context dependent [28].

It is clear that the problem was more quickly, common, and serious in the lambs with BCS 3-4, as their requirements should be increased especially from antioxidants [29]. While the occurrence of the disease in kids was more common in BCS 1-2.5, which clear that mainly poor nutrition is the cause of the disease, as such animals usually suffer from multi deficiencies.

Goats like other ruminants have little ability to manage magnesium level in the blood if dietary levels or absorption are depressed.

With the exertion of muscle during fits of hypomagnesemia, the disease appears. Ill thrift lamb and goat with BCS 1 and 2 that under dietary inadequacies usually develop multi vitamins and minerals deficiencies, signs of copper and iron deficiency that usually concurrent with signs of vitamin E and selenium deficiency in such cases. A relationship between hypomagnesemia and muscular dystrophy in calves was reported by Dehority and Rouss [30]. Additionally, Tollersrud [31] recorded that supplementation with magnesium prevents the development of NMD in calves with vitamin E deficiency.

Vitamin E and Se deficiency affect both the skeletal and cardiac muscles. When the skeletal muscles are affected, symptoms vary from stiffness in gait, to an inability to stand and recumbency. Cardiopulmonary signs usually appear due to the involvement of the heart and muscle of respiration, the diaphragm and intercostals muscles [32].

As an essential trace element, vitamin E and selenium (Se) are important in humans and animals and their deficiency has caused many health problems. Se is an important component of the antioxidant enzymes, such as glutathione peroxidase (GPx), iodothyronine deiodinases (IDD) and thioredoxin reductase (TrxR). Se-containing proteins (selenoproteins) or enzymes (selenoenzyme) [33] have strong antioxidant activity include six groups of the GPx (GPx 1-6). These GPx play an essential mechanism in protecting cells against oxidative damage from reactive oxygen species (ROS) and reactive nitrogen species (RNS), which include hydroxyl radicals, superoxide, nitric oxide, hydrogen peroxide and peroxy nitrite [34,35]. Thus, vitamin E and Se deficiency in lambs and kids resulted in a significant decrease in the serum level of GSH-Px and CAT enzymes and significant elevation of lipid peroxidation; MDA and nitric oxide [36,37]. A similar result was also recorded by Ghanem *et al.* [9].

ROS are highly reactive radicals which secreted from neutrophils and macrophages and pushed into the plasma to be neutralized before they can be taken up by RBCs. RBCs are extremely exposed to endogenous and

exogenous ROS that have shown to damage the RBC membrane [38,39]. All the above may discuss our results which revealed that lambs and kids showed signs of anemia [40].

NMD is a non-inflammatory destructive disease affecting cardiac and skeletal muscle. In a veterinary flock, cardiac troponins are sensitive indicators of myocardial damage caused by cardiac and/or non-cardiac reasons [41]. In sheep medicine, there are few articles about the diagnostic value of cTnI such as experimental cardiac disease in comparative studies and others in the diagnosis of acute white muscle disease [42]. Lowering of serum vitamin E and selenium concentrations resulted in an increase in creatine kinase (CK) activities and troponin I concentrations. Our results revealed significant elevations in cTn I and CPK in dystrophic lambs and kids were similarly to those obtained by Tunca *et al.* [43], Ataollahi *et al.* [44] in lambs and Tharwat *et al.* [45] in kids.

Conclusion

It could be concluded that proper nutrition of dam and young without shortage or excess is necessary; also, vitamin E and Se supplementation should be increased in good bodily conditioned and rapidly growing animals than their counterparts to activate the antioxidant system and reduce oxidative stress. Magnesium deficiency may be considered a predisposing cause for muscular dystrophy, especially in kids. Lamb and kids are viewed differently in their Vitamin E and Se metabolism and requirements.

Conflict of interest

None of the authors have any conflict of interest to declare.

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الملخص العربي

المؤشرات الحيوية للإجهاد التأكسدي في الحملان وصغار الماعز المصابة بالاضمحلال العضلي وعلاقته بتصنيفات حالة الجسم

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تم إجراء هذا العمل لدراسة الاضمحلال العضلي الذي يسببه نقص فيتامين هـ والسليينيوم في الحملان وصغار الماعز وعلاقته بتصنيفات حالة الجسم. وذلك باستخدام ٧١ من الحملان وصغار الماعز و التي تتراوح أعمارهم بين ١-٦ شهور، وكان من بينهم ٥١ حيوان يعاني من الاضمحلال العضلي (٣٨ حمل و ١٣ صغير ماعز). وقد تم تقسيم الحيوانات إلى مجموعات علي حسب تصنيفات حالة الجسم والتغيرات الهيماتولوجيه والبيوكيميائية. وتم إجراء الفحص الإكلينيكي لجميع الحيوانات تحت الدراسة وتجميع عينات الدم والمصل لإجراء الاختبارات السريره. وأظهرت النتائج أن معدل وشدة الإصابة بالاضمحلال العضلي كانت عالية في الحملان سريعة النمو (تصنيف حالة الجسم ٣.٥ - ٤.٥) بينما زادت نسبة الحدوث في صغار الماعز التي تعاني من انخفاض في تصنيف حالة الجسم (١-٢.٥). وبالنسبة للتغيرات الهيماتولوجيه فقد تم تسجيل أنيميا في الحالات المصابه وكانت حدتها اشد في الحيوانات ذات تصنيف حالة الجسم اقل من ٣ . أما بالنسبه للتغيرات البيوكيميائية فقد سجل كلا من فيتامين هـ والسليينيوم والكتاليز والجلوتاثيون المؤكسد انخفاضا ملحوظا بينما لوحظ ارتفاع مستويات كلا من الكرياتين فوسفوكينيز والتروبونين والنيتريك اوكسيد والمالونالدهيد في الحيوانات المصابه وخاصة في الحيوانات ذات تصنيف حالة الجسم اكثر من ٣ وأخيرا فقد سجل مستوي الماغنسيوم انخفاضا ملحوظا في صغار الماعز ذات تصنيف حالة الجسم من ١-٣. وفي الختام فان التغذية السليمه ضروريه للام والصغار دون نقص او زياده، لذلك ينبغي زياده فيتامين هـ والسليينيوم في الحيوانات التي تنمو بسرعة وفي حالة جسميه جيده عن نظيراتها حتي تقوم بتنشيط مضادات الاكسده وتحد من الإجهاد التأكسدي.