4th Sci. Congr. of Egypt. Soc. For Anim. Manag. 25-28 Oct., 2010:157-171 .

THE IMPACT OF LAMBING STRESS ON POST-PARTURIENT BEHAVIOUR OF SHEEP WITH CONSEQUENCES ON NEONATAL HOMEOTHERMY AND SURVIVAL

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ABSTRACT

The expression of appropriate behavioural response from both the ewe and the lamb are extremely important to lamb survival. The aim of this study was to show the effect of length and difficulty of the birth process on the expression of maternal and neonatal behaviour with consequences on homeothermy and survival of the neonate lamb. Data were collected from sixty-one Finnish Landrace x Rahmani crossbred (2^{nd} generation) primiparous ewes and their single born lambs. Based on the average length of parturition, the ewes were grouped into short birth (less than 32.5 min) and long birth (equal to or higher than 32.5 min) classes. The data recorded include maternal and neonatal behaviour, lamb body temperature over the first 3 days of life and survival rate of the neonate lamb during the first week after birth. In addition, blood samples were collected from the lamb, pre-suckling and at 24 and 72 h of birth. The obtained sera were assayed for thyroid hormones (T_3 and T_4), known to be involved in heat production. Ewes had prolonged and difficult births did not show as competent maternal behaviour as mothers with short and un-complicated deliveries, as they were slower to begin to groom their lambs after birth, spent less time licking their lambs, made less low-pitched vocalizations and nosing, more likely to show rejection behaviour (10.34 v 5.4 %, $P < 0.05$), and were more likely to move away as the lamb seeks the udder and attempts to suck (acceptance rate, 55.5 v 64.79 %, $P < 0.05$). Similarly, lambs with prolonged birth that had a difficult delivery were significantly less vigorous after birth, as they taken more time to stand, reach the udder and to suck successfully. These lambs had lower serum concentration of T_3 and T_4, and they were also less able to maintain body temperature after birth and this effect persisted over the first 3 days of life associated with higher neonatal mortality in the first week after birth (11.54 %) compared with only (2.86 %, $P < 0.01$) in lambs from short and non stressful birth process. From the present study it can be concluded that, prolonged deliveries with birth difficulty were one of the main causes of death of large, single-born lambs as it causes the expression of inappropriate behavioural responses from both the ewe and neonatal lamb. Thus, interventions designed to reduce the incidence of prolonged parturitions are likely to be associated with better welfare for the ewe and the lamb and consequently improved lamb homeothermy and survival.

Key words: Lamb; Behaviour, Birth, Thyroid hormones, Homeothermy, Survival.

INTRODUCTION

Lamb mortality in both extensive and intensive system is considered as a major constraint to profitable sheep production **(Haughey, 1991 ; Christley et al., 2003)**. Pre-weaning lamb mortality of 15-20% is common in farming system world-wide **(Wassmuth et al., 2001 ; Darwish et al., 2010)**. Lamb deaths are invariably concentrated in the first week of life reflecting the difficulty of the transition from an intra-uterine life to an extra-uterine existence **(Nowak et al., 2000 ; Hatcher et al., 2009)**. Most lamb deaths result from a failure in bonding between the ewe and the lamb **(Kuchel and Lindsay, 1999)**, thus studies in ewe and lamb behaviour could help to improve lamb survival.

Two main factors; dystocia and starvation-mismothering-exposure have been most often implicated with lamb losses **(Kerslake et al., 2005 ; Nowak and Poindron, 2006)**. Dystocia can be a consequence of lamb birth weight, sire breed, dam pelvic conformation **(Fogarty and Thompson, 1974),** malpresentation, maternal over feeding or prolonged parturition **(Sargison, 1997 ; Everett-Hincks et al., 2007)**. Ewe maternal behaviour is known to be affected by a difficult delivery **(Dwyer et al., 2001)**. In addition, Lambs that indure difficult births have trouble to maintain their body temperature and have retarded behaviours in teat searching and suckling **(Eales et al., 1982)**. Such lambs have increases chances of death when subjected to cold stress or malnutrition.

In sheep, vocalizations represent an important element of mother-young interactions **(Vince, 1993 ;Frédéric Sébe et al., 2007).** Sheep utilize auditory cues togehter with olfactory ones to establish a rapid bond between a ewe and her newborn lambs **(Alexander, 1977 ; Shillito-Walser et al.1981).** In addition, vocalizations are used as a long-distance recognition signals particularly between mother and young, although they appear to acts as a secondary signal to visual information **(Shillito-Walser, 1978)**. On the other hand, lamb bleat may be regarded as an essential adaptive mean for attracting maternal attention **(Brunelli et al.1994 ; Weary and Frazer, 1995).**

A large area of skin through which lamb lose heat, a birth coat of poor insulation value, and being born wet-all add togehter to make the newborn lamb highly susceptible to hypothermia due to exposure **(Eales and Small, 1995).** Thus, the newborn lamb must produce as much heat as

it loses to maintain its body temperature. This partly could be supplied by oxidation of fat from brown adipose tissue **(**BAT) by a process under the control of triiodothyronine (T_3) which produced from thyroxin (T_4) in BAT by the enzyme 5-monodeiodinase **(Dauncey, 1990 ; Brent, 1994),** but mainly by promoting early colostrum ingestion, which is extremely important, in addition to its immunoglobulin; colostrum provides the lamb with fuel to maintain body temperature **(Al-Jassim et al., 1999 ; Charismiadou e al., 2000)**. Therefore, an essential priority for homeothermy and survival of the neonate is the early access to the udder **(Coureaud et al., 2002b).** This study aimed to investigate the effect of birth length and difficulty on the expression of maternal and neonatal behaviour and its relationship with homeothermy and survival of the neonate lamb.

MATERIALS AND METHODS

Animals

This study was carried out at Sakha Animal Production Research Station, Animal Production Research Institute, Ministry of Agriculture, Kafr El-Sheikh Governorate, Egypt, during the period between 2007-2008. Sixty-one Finnish Landrace x Rahmani crossbred (2^{nd} generation) primiparous ewes and their single born lambs were used in this study. Oestrus was not synchronized, and the ewes were naturally mated and had an average body weight of 38.59 kg at mating and 42.18 kg at parturition with 1.72 years an average age. Pregnancy diagnosis was confirmed by transabdominal ultrasonic scanning at Day-70 of pregnancy. Based on the average length of parturition which was recorded in the present study that is 32.5 min, the ewes were grouped into short birth (less than 32.5 min) and long birth (equal to or higher than 32.5 min) classes (Asante et al., 1999). Thirty- five of the ewes fell into the short birth class with an average lamb birth weight of 3.34 kg and twenty-six in the long or protracted birth class with an average lamb birth weight of 4.29 kg.

Management

Ewes were given free access to green fodder (*Trifolium Alexandrium*) during the green season, hay in the dry one and fresh drinking water. Concentrate mixture (cotton seed cake, Soya bean meal, yellow corn, limestone and mineral mixture) containing 16.6% crude protein, 12.7 % crude fiber and 73.4 % TDN was provided during pregnancy at a rate of

400 gm daily /ewe.This amount was increased gradually till reach 1000 gm/ewe at the late stage of pregnancy (last 4-6 weeks). Ewes were vaccinated with 2 ml clostridia vaccine (Covexin, Schering-Plough Company) subcutaneously at week 17th of pregnancy. Ewes were housed in semi- covered large pens (6 m ×20 m), in groups of 30 ewes / pen.

Two weeks prior to the expecting lambing time, ewes were transported into well straw-bedded pens (6 m x 9 m), in groups of approximately 10-11 ewes / pen for lambing. Ewes due to lamb, were kept under 24-hour observation for 2 weeks for the exact time of lambing. At lambing, ewes were allowed to give birth without assistance; however, if the ewe is seen to strain for long time without further progress of the lamb, assistance is required. Lambing assistance was provided 1h after the water bag breaks without appearance of any part of the lamb (n=3) and /or 2h after parts of the lamb were seen at the vulva with no further progress being made(n=4) **[Paula Simmons, 1989 ; Dwyer, 2003].**The given assistance involved firstly correcting lamb presentation then manually delivered the lamb. Since assistance was based on time intervals, the interval prior to assistance was accepted as an indication of the true length of parturition **(Cloete et al., 2002**).

Data recording

Once any part of the lamb appears at the vulva, the observation was started immediately by focal observation (Martin and Bateson 1993) using a video camera (Sony, 450X, Japan), and continued for the first 2 h after birth. The data recorded include length of parturition, defined as the interval (in minutes) from the appearance of fluids until the birth of the lamb **(Dwyer, 2003)**, maternal behaviour (latency to groom, time spent grooming, frequencies of low-pitched bleat and nosing, lamb rejection and acceptance of lamb suck attempts), neonatal behavioural progress including latency to first stand, reach the udder and sucking and the average time spent sucking during the first 2h following birth as well as lamb bleating, pre-suckling lamb body temperature and lamb temperature at 24 and 72 h of life, and neonatal mortality over the first week of life.

Blood assay

Sampling

Once the lamb stands successfully, it was caught and a 3-ml blood sample was taken prior to suckling by jugular venipuncture within few minutes

of entering the lambing pen. Rectal temperature was also recorded at this time. Blood samples were then centrifuged (3000 rpm / 20 minutes). The obtained sera were separated and stored frozen at–20^{o}C until assayed for T_3 and T_4. Blood sampling and temperature recording procedures were repeated at 24 and 72 h after birth **(Schermer et al., 1996 ; Dwyer and Morgan, 2006)**.

Analytical procedures

Serum **c**oncentrations of T_3 and T_4 hormones were determined using a solid phase competitive chemiluminescence immuno-assay system (Elecsys 2010, Roche, Diagnostic, Mannheim). Concentrations were determined using kits, controls, mono-clonal mouse antibodies and reagent supplied by Roche, Diagnostic, 2005 .The intra – and inter assay coefficients of variation (C.V. %) were 3.6 and 5.4% for T_3 and 4.7 and 6.9 % for T_4.The minimum detectable levels of the assay were 0.195 ng /ml and 0.42 µg /dl for T_3 and T_4 respectively.

Statistical analysis

Ewe maternal behaviour were compared between the two birth classes using independent *t*-test and Chi-square test. Neonatal lamb behaviour, concentration of T_3 and T_4 and lamb rectal temperature over the first 3d of life were compared between the two birth classes using independent *t*-test. Lamb mortality rate during the first week of life were tested between the two groups using Chi-square test. Statistical analyses were computed using SAS version 12.0 (SAS, 1987). Differences were considered statistically significant at p=0.05 or less. All data are expressed as Means ± S.E. except the rejection behaviour, acceptance of lamb suck attempts and lamb mortality rate which expressed as percentages.

RESULTS AND DISCUSSION

Ewe maternal behaviour

In this study, ewes with prolonged labour and complicated deliveries were fail to show better maternal care and frequently abandon their new born lambs as compared to those with short and unassisted births (Table 1)

In sheep, as in many other species, an intensive period of behavioural interactions between the ewe and her new born lamb are likely to occur after birth. The ewe show intense licking and grooming of the wet lamb

(Dwyer, 2007), and emit frequent low-pitched bleat (care given bleat emitted by the ewe to her newborn lamb to strengthen the bonding with lamb) **(Frédéric Sébe et al., 2007).**These behaviours are of importance to promote the bonding formation between the ewe and her newborn lams and also encourage the early suckling by the lamb. The findings of the present study showed that, these behaviours are likely to be less frequent in ewes with prolonged and difficult births than those with short and un-complicated deliveries. Additionally, the ewe devotes the majority of her grooming time immediately after parturition **(Alexander, 1988),** and as the lamb dries, grooming wanes. The present study revealed that ewes that experienced prolonged and difficult births were significantly slower to begin to groom their lambs after birth as shown previously **(Arnold and Morgan, 1975; Poindron et al., 1984)**. On contrast, the decline in grooming attention with time since the birth of lamb was inversely related to an increase in sniffing or nosing attention to the lamb **(Dwyer and Lawrence, 1998)**. Our data demonstrated that, Lambs with long and complicated births had received less nosing attention than those with short and non stressful birth process. This is likely to have real consequences on survival of lamb and the strength of bond formed between ewe and lamb.

Table (1): Effect of length and difficulty of birth process on maternal behaviour.

Lambing process / Behavioural element	**Short uncomplicated birth**	**Prolonged birth with assistance**	*P* - Value
Latency to groom (sec)	14.286± 0.85	63.5±4.21	< 0.001
Time spent grooming (min)	51.72± 1.53	45.53± 1.26	< 0.01
Low- pitched bleat frequency	381.00±12.75	338.92±15.125	< 0.037
Nosing frequency	49.77±2.08	41.46±2.238	< 0.01
Acceptance of lamb suck attempts (%)	64.79	55.5	< 0.05
Rejection behaviour (%)	5.4	10.34	< 0.05

A poorer quality of maternal care showed by ewes that experienced prolonged and difficult births may be explained on the basis of, a delay or prolong parturition may act as a source of stress for ewes. These ewes

may fail to show better maternal care and frequently abandon their lamb as had been demonstrated previously by Nowak and Poindron, 2006 and also shown in the current study. Moreover, ewes with prolonged labour were more likely to require assistance at the birth of their lambs and this was associated with a delay in the onset of grooming behaviour and is known to inhibit maternal behaviour in several species (Alexander, 1988).

The results of the present study also showed that when the lamb stands and try to find the udder for initial suckling, ewes with short and unassisted deliveries had higher rate of acceptance to lamb sucking attempts (64.79 %) when compared with those of prolonged and difficult births (55.5%), and were less likely to show rejection behaviour towards their neonate (5.4 v 10.34 %, $P < 0.05$, Table 1). This is likely to be attributed to the less stressful birth process of these ewes as a result of increasing in the speed and ease of parturition.

Neonatal lamb behavioural progress:

Our data showed that, birth length and difficulty had a major impact on lamb neonatal behaviour (Table 2). Lambs with short and un-complicated deliveries those requiring no assistance at birth were significantly more active in the first 2h following birth as compared to those with prolonged and difficult births, since they stood and suck quickly after birth, and were more likely to suckle within the first 2h following birth.

Table (2): Effect of length and difficulty of birth process on neonatal behaviour.

Lambing process / Behavioural element	**Short uncomplicated birth**	**Prolonged birth with assistance**	*P*- value
Latency to:			
First stand (min)	15.387±0. 5	18.21±0.65	< 0.001
Reach the udder (min)	23.76±0.7	27.65±0.91	< 0.001
First suck (min)	33.92±0.99	39.01±1.06	< 0.001
Time spent sucking / 2h (min)	13.31±0.73	**10.483±0.78**	< 0.01

Neonatal lambs may experience pain and injury as a result of prolonged and difficult births. Birth injury is reported to present in over 80% of

lambs classified as parturient deaths and up to 57% of lambs dying from starvation-mismothering-exposure (Haughey, 1993). These lambs can suffer a range of injuries; such injuries include brain and liver damage, fractures (jaws, spinal column, ribs and limbs), dislocations, abrasions and bruises (Alexander, 1984 and Henderson, 1990). These injuries cause pain and if they are not immediately fatal, usually impaired sucking and locomotor activities of birth-injured lambs (Haughey, 1980; and Dwyer, 2003) as reported in the present study, thereby interfering with mother-young interactions and other behaviours that promote homeothermy and survival of these lambs.

Lamb bleating activity

In the present study, lambs with prolonged and difficult births took shorter time to vocalize for the first time after birth and tended to bleat frequently during the observation period than those with short and unassisted births (Figure 1). The maternal data of this study showed that these lambs had received delayed and less maternal care. Thus, the changes in lamb bleat rate of the current study were consistent with the vocalizations of young being indicators of need, supporting the view of a link between lamb bleat and the quality of receiving maternal care that had been suggested previously by Garcia-Gonzalez and Goddard, 1998. For that, this may explain the higher frequency of bleats in lambs with long and more complicated deliveries that received low level of maternal care from their mothers. Although, in another view with lamb bleat, Nowak, 1990 has been suggested that a high bleating activity by lambs improves the quality of the mother-young bonding by establishing better communication and improving mother recognition.

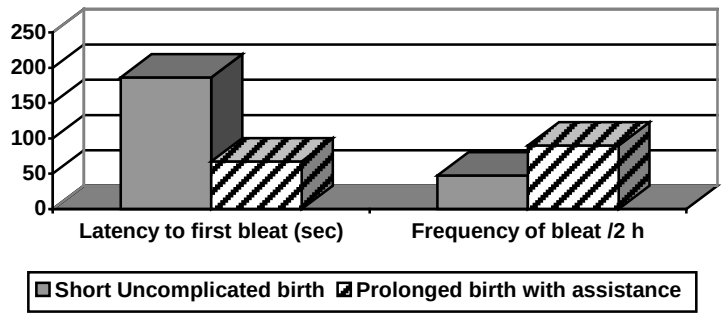

Fig. (1): Effect of length and difficulty of birth process on lamb bleating activity.

*** P<0.001

Lamb homeothermy

In the present study, lambs with short and less stressful birth process had higher circulating concentration of T_3 and T_4 (Table 3), and also had higher rectal temperature over the first 3d of life than lambs with prolonged and difficult births (Figure 2). These significant differences between the two birth classes in lamb temperature and concentration of T_3 and T_4 were markedly observed pre-suckling, although, there was also still a tendency for birth stress to influence these measures at 24 and 72 h after birth.

Table (3): Effect of length and difficulty of birth process on lamb thyroid hormones .

Lambing process / Lamb age	Short uncomplicated birth	Prolonged birth with assistance	*P*-Value
Pre-suckling:			
T_3 (ng /ml)	3.81±0.17	3.1±0.22	0.01
T_4 (µg /dl)	9.587±0.29	8.032±0.37	< 0.001
At 24h of birth:			
T_3 (ng /ml)	4.585±0.23	3.78±0.29	< 0.03
T_4 (µg /dl)	10.59±0.36	9.29±0.37	< 0.01
At 72 h of birth:			
T_3 (ng /ml)	4.97±0.23	4.085±0.30	< 0.02
T_4 (µg /dl)	10.91±0.4	9.44±0.39	< 0.01

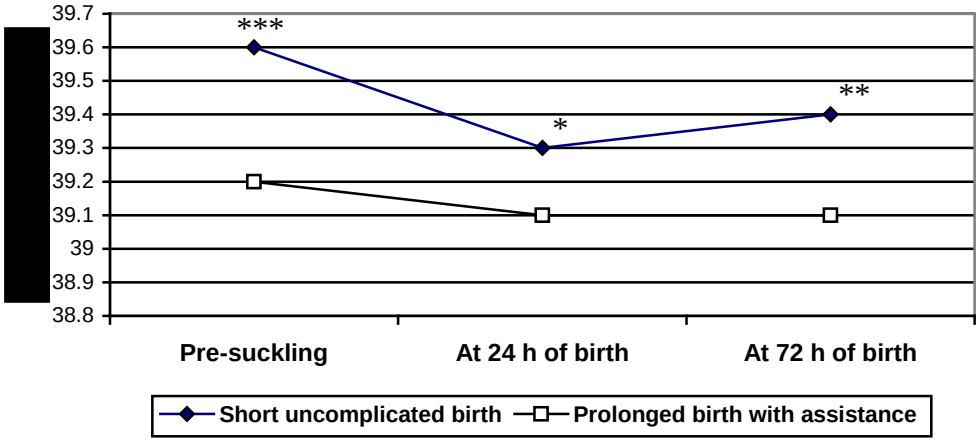

Fig (2): Effect of length and difficulty of birth process on lamb rectal temperature.
*** P<0.001, **P<0.01, *P<0.05

Inactive lamb may experience hunger due to inability to suck sufficient milk; this can lead to an inability to produce sufficient heat and hence to hypothermia (Slee and Springbett, 1986 and Dwyer and Morgan, 2006), where the newborn lamb has limited energy reserves stored in its body and is totally dependent on its mother for its energy supply (Eales and Small, 1995). Likewise, newborn lambs suffering from pain as in case of prolonged and difficult births may fail to suck sufficiently from their mothers (Eales and Small, 1981 and Eales et al., 1982) and will experience hunger associated with impaired thermoregulation in the neonate as shown in this study. This finding was underlined by low concentrations of thyroid hormones (T_3 and T_4) in these lambs which known to be involved in heat production associated with low body temperature over the first 3 d of life. On the other hand, as grooming behaviour has been considered to dry and to prevent heat loss from the newborn lamb (Levy and Poindron, 1987), ewes with prolonged and difficult births that took longer time to lick their newborn lambs after birth as reported in this study, their lambs were more likely to succumb to lower body temperature.

Neonatal lamb mortality

The results of the present study showed that a long duration of birth and a more complicated delivery were associated with a higher rate of lamb mortality during the first week of life (11.54 v 2.86 %, $P<0.01$, Fig. 3). Protracted labour increase the likelihood of suffering birth trauma and fetal hypoxemia associated with impaired heat production in the newborn lamb (Comline and Silver, 1972 and Haughey, 1993) and, if they are not immediately fatal, usually lead to delivery of an injuried lamb. Such lambs in addition to suffering pain as a result of birth trauma are generally less vigorous at birth, slower to stand and suck successfully and may establish a weak bond with the mother (Eales et al., 1982 and Haughey, 1980). Additionally, a difficult lambing was also associated with inappropriate behavioural response from the ewe (Dwyer et al., 2001 and Poindron et al., 1984). For that, these factors may increase the probability of neonatal death in these lambs (Haughey, 1991 and Cloete et al., 1993), since the ewe and lamb behaviour at birth has a large effect on lamb survival (Nowak, 1996; Hinch, 1997 and Darwish et al., 2010).

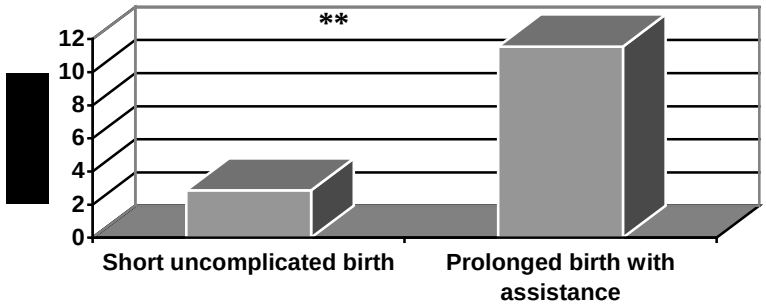

Fig. (3): Effect of length and difficulty of birth process on neonatal lamb mortality. ** P<0.01

CONCLUSION

In conclusion, this study had demonstrated that prolonged lambing and birth difficulty were significant risk factors, affecting the post-parturient behaviour of ewe and neonatal lamb with more severe consequences on homeothermy and survival of the neonate lamb. Thus, selection for an increase in the speed and ease of parturition are more likely to be associated with better lamb survival.

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تأثير مدة وعسر الولادة علي سلوك الأغنام بعد الولادة وعلاقة ذلك بدرجة حرارة ومعدل نفوق الحملان

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تعتبر مشكلة نفوق الحملان أحد أهم المشاكل التي تواجه تربية الأغنام ويرتبط بهذه المشكلة العديد من العوامل التي تؤثر عليها. وقد أجريت هذه الدراسة لبيان تأثير أحد هذه العوامل وهى مدة وعسر الولادة علي سلوك الأغنام بعد الولادة وتأثير ذلك علي درجة حرارة ومعدل نفوق الحملان. أستخدم فى هذه الدراسة عدد (61) أغنام خليط رحماني فنلندي (الجيل الثاني) تم تقسيمها حسب مدة وعسر الولادة الى مجموعتين أحداها ذات مدة ولادة قصيرة (أقل من 32.5 دقيقة) وعددها 35 حيوان ومجموعة آخرى مدة ولادتها طويلة وبعض منها أحتاج مساعدة عند الولادة (32.5 دقيقة أو أكثر) وعددها 26 حيوان. تم تسجيل سلوك النعاج والحملان بعد الولادة ، درجة حرارة الحملان وتركيزهرمونات الغدة الدرقية (T3 and T4) المرتبطة بإنتاج الطاقة خلال الثلاث أيام الأولى ومعدل نفوق الحملان خلال الأسبوع الأول من الولادة. وقد أسفرت النتائج عن الآتي:-

1- **تأثر سلوك النعاج بعد الولادة بمدة وعسر الولادة حيث كان سلوك الأمومة أكثر تحسناً في النعاج ذات مدة الولادة القصيرة عنه في النعاج ذات مدة الولادة الطويلة وظهر ذلك بوضوح في إرتفاع وقت لحس هذه النعاج لحملانها وزيادة معدل الصوت المنخفض المصاحب له وأيضا معدل شم النعاج لهذه الحملان . وهذه السلوكيات ذات أهمية قصوى في إرتباط النعاج بحملانها . أيضا كانت هذه النعاج أكثر استجابة لمحاولات رضاعة الحملان عنه في النعاج ذات مدة الولادة الطويلة.**
2- **بالمثل تأثر التطور السلوكي للحملان بعد الولادة بمدة وعسر الولادة حيث كانت الحملان ذات مدة الولادة القصيرة أكثر نشاطاً بعد الولادة وتمكنت من الوقوف والوصول إلي الضرع أسرع من الحملان ذات مدة الولادة الطويلة ولهذا إستطاعت الرضاعة والحصول علي السرسوب الغني بمكوناته فى وقت أقل.**
3- **إرتفاع تركيزهرمونات الغدة الدرقية ودرجة الحرارة خلال الثلاث أيام الأولى فى الحملان ذات مدة الولادة القصيرة عنه الحملان ذات مدة الولادة الطويلة.**
4- **أدي تحسن سلوك النعاج والحملان بعد الولادة في الأغنام ذات مدة الولادة القصيرة عنه في الأغنام ذات مدة الولادة الطويلة إلي انخفاض معدل نفوق حملانها (2.86% مقابل 11.54%) خلال الأسبوع الأول من الولادة.**

من هذه الدراسة نستنتج أن مدة وعس ر الولادة له تأثير واضح على سلوك النعاج والحملان بعد الولادة وأيضا على درجة حرارة ومعدل نفوق الحملان.