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FACTORS AFFECTING PHYSIOLOGICAL REACTIONS OF RABBITS IN RELATION TO ENVIRONMENTAL TEMPERATURE UNDER SUB-TROPICAL CONDITIONS

By

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Breed differences were studied in white "Giza", white "Seds" and white Bouscat rabbits. Slight but significant breed differences were observed in body temperature and highly significant breed differences for respiration and pulse rates were obtained.

Different colour varietie of fawn, brown and white "Seds" rabbits were used in this experiment. Highly significant differences were obtained for different studied physiological reactions (skin, fur, ear lobe temperatrues, respiration and pulse rates), however, differences in body temperature were not significant. The fawn coloured rabbits always showed the highest values while the brown animals showed the lowest values, this should be due to that dark pigments in brown furs facilitate heat exchange.

Age differences showed small but significant differences in the values of all physiological reactions with exception of skin temperature which was not significant. Body temperature, respiration rate and pulse rate decreased slightly by advancing age. Ear lobes of young rabbits showed lower temperatures than older ones due to its thin skin, coated with furs of less density than older ones.

Sex had no significant effect on body temperature. Skin temperature (back) was lower in males than in females due to thick skeletal muscles and skin at this region.

On the other hand, the thick dense hair coat in females conserve a larger quantity of heat. Small but not significant differences were observed in ear lobe temperatures. Females were higher in respiration rate than males.

Physiological state of the female has a significant effect on respiration rate while it was insignificant on body temperature and pulse pulse rates. Dry rabbits showed the highest body temperature followed by early pregnant, lactating pregnant and late pregnant group, respectively. Respiration and pulse rate were always the highest in lactating rabbits followed by late pregnant and early pregnant groups, while dry rabbits had a unique situation of high respiration rate, according to its high muscular activity.

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The physiological reactions of rabbits against high environmental air temperature vary acoroding to breed, age, sex and the physiological state of the female differences.

Breed:

The ability of rodents to regulate their body temperature against numerous environmental conditions varies from one breed to another due to the variations in their body size, body conformation, necturnal habits and the efficiency of chemical, physiological and physical thermoregulators of every breed Schmidt-Nielsen, (1964). Since the relative surface area of the small animals is greater than that of large animals, the heat load on their bodies will also be greater. The normal temperature of rabbits varies from 38° to 40.1°C due to breed differences Johnson *et al.*, (1957). He also pointed out that the lethal rectal temperature of rabbits varied from 42° to 43°C.

Age:

Heat production shows a general increase in rabbits with advancing age. Besides, the evaporative cooling also increases. The ratios of evaporative cooling, thyroid activity, heat production of both males and females, at 38.3°C. environmental temperature to 39°C., increases with the increasing of age indicating a certain extent of adaptation (Johnson *et al*, 1957). Little changes are observed in the respiration rate of rabbits with advancing age, though a marked difference is noted between animals reared at different environmental temperatures. Pulse rate declines with increasing age coinciding with the increase in body weight. However, between 50 and 100 days of age, rabbits show no increase in pulse rate (Johnson *et al*, 1957)

Sex:

Differences are sometimes noted between male and female rabbits in the physiological reactions due to changes in ambient air temperature. The average value of rectal temperature of New Zealand White rabbits reared at temperatures of 28.3°C. and 9°C. are 38.8 and 38.1°C in males respectively. In the females, it was 38.8° and 38.4°C. respectively (Johnson *et al*, 1957). The previous authors also stated that increasing environmental temperature from 18.3° to 33.3°C. raised the respiration rate from 69 to 190 per minute in male rabbits and from 75 to 195 in females. When environmental temperature increased to 39.5°C., panting was marked and the respiration rate increased to 260 – 277 per minute in males and females respectively. Pulse rate increases from 129 to 184 in male rabbits and from 136 to 183 per minute in the females by raising the air temperature from 18.3° to 33.3°C. (Johnson *et al*, 1957).

Physiological State of the Female:

The relationship between the physiological state of the female and body reactions to the changes in environmental conditions had not been studied.

Material and Methods

This work has been carried out in the Poultry Research Station, Faculty of Agriculture, Cairo University, Giza, Egypt at the period from January 1963 till December 1964. Egyptian native white "Giza" rabbits as well as Egyptian native "Seds" breed of fawn and brown fur colours were used. Rabbits of both two previous breeds weight 3 and 4 kilograms for males and females respectively. Also Bouscat rabbits were used in the present study. Adult animals were housed individually in a brick battery concrete building. The experimental animals were fed on concentrate ration composed of wheat bran and barley, Egyptian clover during winter and shopped green maize leaves during summer were supplied.

Body temperature was measured by inserting the clinical thermometer rectally for one minute. Skin, hair and ear lobe temperatures were measured by a thermocouple of pointed probe while respiration and pulse rates were estimated by a manual counter. The study comprised five experiments:

Breed Differences:

Eight adult dry female rabbits, each of white "Giza" (native breed), white Bouscat and white "Seds" (native breed), living under the same conditions were used. Air temperature, body temperature, skin and hair temperatures of the back, temperature of the mid region of external surface of the ear lobe, respiration rate and pulse rate were recorded for every individual twice daily at 7 a.m. and 1 p.m. throughout one week.

Colour Differences:

Twenty-four "Seds" baladi adult females were divided into three equal groups of different colours, white, fawn and brown, were used. The observations were recorded in the same manner previously mentioned.

Age Differences:

Eighty-four white female "Giza" rabbits of different ages were divided into seven equal groups including 1.5, 2, 3, 4, 5, 6 and 12 months of age were used. Air temperature, body temperature, skin and hair temperatures, temperatures of mid external surface of ear lobe, respiration rate and pulse rate as well as air temperature were recorded at morning daily for one week.

Sex Differences:

Fifteen adult (2 years old) white "Giza" rabbits of both sexes were used for this study throughout a whole year (1963). The test was carried out at weekly intervals for three diurnal day times, 7 a.m., 1 p.m. and 7 p.m.

Air temperature, body temperature, skin and hair temperatures, ear lobe temperature, respiration rate and pulse rate were also recorded for every individual.

Physiological State of the Female:

Four equal groups of dry, early pregnant (7 days of pregnancy), late pregnant (16 days of pregnancy) and lactating pregnant female "Giza" rabbits were used. Body temperature, respiration rate and pulse rate as well as air temperature were recorded three times daily at 7 a.m., 1 p.m. and at 7 p.m., for six days during January 1963.

Results and Discussion

Breed Differences:

There were slight but significant breed differences in the body temperature between white "Giza", white "Seds" and white Bouscat rabbits although the differences did not exceed 0.2°C. (Fig. 1). It is interesting to note that the New Zealand rabbits have similar body temperature to "Giza" rabbits (Johnson *et al.*, 1958). However, the "Giza" rabbits showed the least values and were less affected by the variations in air temperature (Fig. 1). This seems to be due to the long time of both natural and artifical selection for adaptation to the Egyptian weather conditions.

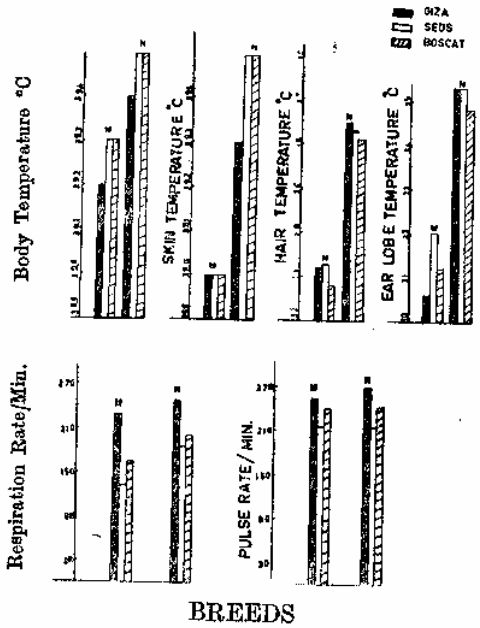

FIG. 1.—Effect of Breed Differences on Physiological Reaction of Rabbits at Morning and at Noon.

"Giza" rabbits seem to possess thin skinned ear lobes so their ear lobe temperatures were affected immediately by air temperature more than other breeds in this study. The "Giza" rabbits showed the lowest ear lobe temperature at 25°C. air temperature and the highest temperature at 32°C. air temperature (Fig. 1). Skin temperature showed no breed differences. Also at any environmental air temperature range, no significant differences occurred in hair temperature between breeds (Table 1). However, Bouscat rabbits showed lower hair temperature than the other two breeds at 25°C. air temperature, due to its fur coat structure, namely, density, length, thickness and medullation of hairs.

TABLE 1.—ANALYSIS OF VARIANCE FOR BODY REACTIONS OF RABBITS AS INFLUENCED BY BREED, DIURNAL VARIATIONS AND THEIR INTERACTIONS.

Body reaction	Source of variation	D. F.	Mean square
Body temp	Breed	2	0.17*
	Diurnal	1	1.50
	Interaction	2	0.005
	Error	144	0.04
Skin temp.	Breed	2	0.09
	Diurnal	1	7.98**
	Interaction	2	0.47**
	Error	144	0.07
Hair temp.	Breed	2	2.11
	Diurnal	1	374.15**
	Interaction	2	0.39
	Error	144	1.21
Ear lobe temp.	Breed	2	1.21
	Diurnal	1	638.96**
	Interaction	2	4.21
	Error	144	
Respiration rate	Breed	2	8545850**
	Diurnal	1	39952**
	Interaction	2	5165.50*
	Error	144	1106.78
Pulse rate	Breed	2	21198**
	Diurnal	1	371
	Interaction	2	63
	Error	144	387.65

** Significant at 1% level of probability.

* Significant at 5% level of probability.

The "Giza" rabbits showed a very high respiration rate which was 150% of the Bouscat and 200% of the Seds rabbits at the same environmental air temperature. These results are similar to those reported by Pearson (1948) showing wide breed differences in the mice with respect to this character. Also similar results were observed with respect to pulse rate (Fig. 1).

Colour Variety Differences :

Within the "Seds" breed, the different coloured varieties showed some variations in their reactions. The fawn animals showed always the highest values, the brown animals had the lowest values in body, skin, ear lobe and hair temperatures . Differences were more pronouced at low environmental temperature (in the morning) than at high temperature (at noon), (Tables 2 and 3).

TABLE 2.—COLOUR EFFECT ON BODY REACTIONS OF "SEDS" RABBITS AT 7 A.M. (AVERAGE AIR TEMPERATURE 25°C.)

Items \ Colour	White		Fawn		Brown	
	Average	Range	Average	Range	Average	Range
Body temp. . . .	39.3	39.0–39.7	39.3	39.0–39.8	39.1	38.7–39.5
Skin temp.	38.8	38.0–39.5	39.0	38.3–39.5	38.8	38.2–39.4
Hair temp.	32.5	30.7–34.5	32.7	30.9–34.5	31.4	29.8–32.8
Ear lobe temp. . .	30.1	27.1–35.3	31.3	27.7–36.4	28.7	26.8–30.9
Respiaration rate .	130	88–212	222	148–300	195	148–260
Pulse rate	214	160–248	219	180–276	217	188–260

TABLE 3.—COLOUR EFFECT ON BODY REACTIONS OF "SEDS" RABBITS AT 1 P.M. (AVERAGE AIR TEMPERATURE 32.5°C)

Items \ Colour	White		Fawn		Brown	
	Average	Range	Average	Range	Average	Range
Body temp. . . .	39.5	39.0–40.1	39.6	39.3–40.0	39.5	39.0–40.0
Skin temp.	39.4	38.8–39.9	39.6	39.0–40.8	39.2	38.6–39.9
Hair temp.	36.6	35.3–37.8	36.6	35.6–37.7	35.9	33.5–36.0
Ear lobe temp. . .	36.0	33.6–37.8	35.9	33.9–37.8	35.1	32.9–37.0
Respiration rate .	184	142–220	252	180–320	250	192–344
Pulse rate	212	172–256	260	216 288	255	224–320

It seems that the dark colour (brown) of the hair and skin facilitates heat dissipation from the body core and surface, so reduces the internal and external body temperature. Howerver, the high rate of respiratior must be related to this reduction of body temperature through waten vaporization from the respiratory surfaces.

Highly significant differences were obtained by "F" test according to colour and diurnal variations for all physiological reactions except the variations in body temperature (Table 4 and Fig. 1).

TABLE 4.—ANALYSIS OF VARIANCE FOR "SEDS" RABBITS AS INFLUENCED BY COLOUR, DIURNAL VARIATIONS AND THEIR INTERACTIONS ('F' TEST)

Body reaction	Source of variation	D. F.	Mean squares
Body temp.	Colour	2	0.29
	Diurnal	1	3.19
	Interaction	2	0.11
	Error	144	1.15
Skin temp.	Colour	2	0.89**
	Diurnal	1	11.43**
	Interaction	2	0.26
	Error	144	0.12
Hair temp.	Colour	2	16.12**
	Diurnal	1	323.03**
	Interaction	2	1.20
	Error	144	0.74
Ear lobe temp.	Colour	2	37.95**
	Diurnal	1	116.27**
	Intraction	2	9.33
	Error	144	2.68
Respiration rate	Colour	2	91272**
	Diurnal	1	8213**
	Interaction	2	2473.50
	Error	144	1130.74
Pulse rate	Colour	2	20068.50**
	Diurnal	1	5233**
	Interaction	2	2031**
	Error	144	405.42

** Significant at 1% level of probability.

* Significant at 5% level of probability.

Age Differences :

Small but significant differences were observed in body temperature due to age differences in white "Giza" rabbits (Fig. 2). Rabbits are born bare from hair which grow after about two weeks. After about one month only, rabbits become able to regulate their body temperature. The foetus is surrounded by the high environmental temperature of the uterus, thus after parturation it needs time for development of homeothermy (Brody, 1945). Immature animals have a smaller thermogenic reserve or thermal adaptability than mature ones (Giaja, 1925). Body temperature of young rabbits decreased smoothly by age advancement. In general, the resting metabolism is much higher in young than in old animals due to higher levels of feeding consumption or to a greater efficiency of energy conservation, (Johnson *et al.*, 1957). Also Brody (1945), stated that the metabolism per unit surface area decreased by advancing age in rat as it decreased from 1200 to 800 calory/sgm/day from 40 to 120 days of age.

Changes in both respiration and pulse rate were not very high, but they were of significant difference (Fig. 2). Respiration and pulse rates decresed

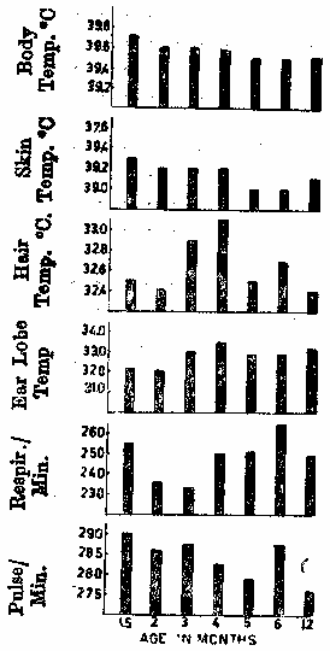

FIG. 2.—The Effect of Age Differences on Physiological Reactions of Rabits

slightly by advancing age. Also, Johnson *et al.* (1957) data showed similar results in New-Zealand rabbits. Skin temperature of rabbits also decreased slightly by the advancement of age, the difference was not significant (Fig. 2). These differences occured due to the higher body temperature in young rabbits than in older ones. Moreover, the thickness of the skin in small rabbits was less than that of older ones, and thus facilitate the flow of heat to the surface. Ear lobe temperature changes showed significant differences in relation to age advancement. It decreased by advancing age. This should be due to that ear lobes work as thermoregulator organs in rabbits. This occurred under the control of arteriovenous anastomsis shunts Johnson *et al.* 1957 and Konradi, (1960), which at high environmental air temperature (conditions in this study), causes vasodialtation in the ear lobes of older rabbits at a high rate than younger ones. These differences occurred to facilitate heat loss from the ear lobes of the first group. While the younger group lost larger amount of heat through their thin skin, coated with fur of less density, than older rabbits. Hair temperature was mainly constant at different ages as it was affected in the first place by the environmental air temperature which was the same in all groups during this study (Fig. 2).

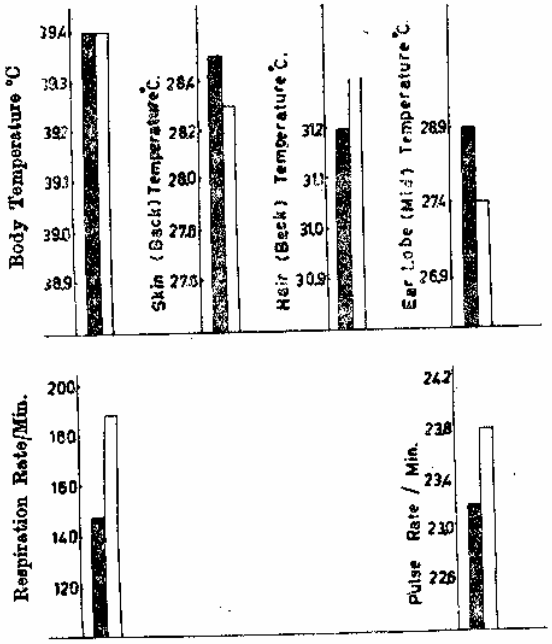

FIG. 3.—Effect of Sex on Different Physiological Body Reactions of Rabbits

■ Male □ Female

Sex Differences:

There were no significant sex differences in body and skin temperatures in "Giza" rabbits at an average air temperature of 25.5°C. Similar results were found in New-Zealand rabbits at environmental air temperature of 28°C. (Johnson *et al.*, 1957). Skin temperature at the back region was lower in males than females. It seems that the flow of heat from the body core to the skin surface is slower in males than in females due to their thick skeletal muscles and skin at that region. On the other hand, skin preserve heat in great quantities in females than in males due to their dense hair coat (Fig. 3).

Sex difference was observed in ear lobe temperature by 1.4°C., but this difference was not significant. The ear lobe surface area was greater while their skin was thinner in females than in males. This structure leads to rapid heat dissipation from ear surface in females.

The higher respiration rate in female rabbits seems to be related with the basal metabolic rate which may be higher than that of males per unit of body weight due to the small size and light weight of females (Brody, 1945). It should be noted that all these previous sex differences were not significant at level of 1% of probability.

Physiological State of the Female:

The experiment was planned to find out the effect of the reproductive state of the female rabbits on their physiological reactions to climatic conditions. In general, the dry rabbits showed the highest body temperature while the late pregnant rabbits showed the lowest temperature than both the early pregnant and pregnant lactating groups (Table 5). This result may be due to that the dry females were very active and exercise rapid and continuous muscular movements, while the late pregnant animals were calm. (Table (6) showed that diurnal variations were highly significant for body temperature while they were insignificant for physiological state of the female. At low environmental air temperatures of 11.5° and 12.0°C., the animals in all groups showed higher respiration and pulse rates at highest air temperatures of 12.5°–17.5°C. This should be due to that the animals exercise higher muscular and lungual activity during cold weather, causing this rise in res piration and pulse rate. Also to heep the ear lobes and extremities temperature fairly hot during cold weather, the animals increase their blood flow through increasing their pulse rate. Table (6) shows that the diurnal differences within each case of physiological state were highly significant for respiration rate. On the other hand, pulse rate differences were not significant. The respiration and pulse rates were always the highest in the lactating rabbits followed by the late pregnant group and then by the early pregnant group, due to the great need of active metabolic processes and greater quantities of oxygen in the first two groups (Brody, 1945). The dry animals have unique situation of high respiration rate according to their high muscular activiy.

TABLE 5.—THE EFFECT OF PHYSIOLOGICAL STATE OF FEMALES ON REACTION OF BODY TO ENVIRONMENTAL CONDITIONS

Items	Physiological state of females	Day time		
		M	N	E
Body temp. °C	Air temp.	14	21	16.5
	Dry	38.7	39.1	38.9
	Early pregnant	38.6	38.9	38.9
	Late pregnant	38.5	38.7	38.8
	Lact. and pregnant	38.6	38.9	38.8
Respiration rate	Dry	175	200	193
	Early pregnant	157	181	185
	Late pregnant	170	185	185
	Lact and pregnant	177	215	203
Pulse rate	Dry	249	268	258
	Early pregnant	249	272	259
	Late pregnant	252	275	263
	Lact. and pregnant	252	274	263

TABLE 5.—ANALYSIS OF VARIANCE OF FEMALE "GIZA" RABBITS AS AFFECTED BY THEIR REPRODUCTIVE PHYSIOLOGICAL STATE ('F' TEST)

Items	Source of variation	D. F.	Mean squares
Body temperature	Physiological state	3	0.12
	Diurnal variations	2	0.33**
	Error	47	0.07
Respiration rate	Physiological state	3	908.67**
	Diurnal variations	2	2837.50**
	Error	47	90
Pulse rate	Physiological state	3	72
	Diurnal variations	2	2091.50
	Error	47	173.90

** Significant at 1% level of probability.

* Significant at 5% level of probability.

RFEERENCES

BRODY, S., (1945).—*Bioenergetis and growth.* Chapter 11, Reinhold Publ. Co. N.Y.

GIAJA J. (1925).—Le marge de thermogénéses et al quatient metabolique au cours du development embryonnaire et de le corisance. *Ann. Physiol. Physico - Chimie biol.* **1**: 569-575.

JOHNSON, H.D., A. C. RAGSDALE and C.S. CHENG (1957).—Influence of constant environmental temperatures on growth responses and physiological reactions of rabbits and cattle. *Univ. Ms. Agric. Exp. Sta. Res. Bull.* Nos, **646, 648.**

KONRADI, C. (1960).—*Textbook of Physiology.* Chapter 16. Edited by Bykov, K.M., Foreingn Languages. Publ. House Moscow.

PEARSON, O.P., (1948).—Metabolism of small mammals. *Science,* 108 : 44-59.

SCHMIDT-NIELSEN, K., (1964).—*Handbook of Physiology.* Chapter 12. Edited by Dill D.B. American Physiological Society Washington.

العوامل المؤثرة على التنظيم الفسيولوجى للحرارة فى الأرانب وعلاقة ذلك بالحرارة الجوية فى المناطق شبه الحارة

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الملخص

درست الاختلافات بين أنواع الجيزة أبيض وأبيض سدس والبوسكات الأبيض من الأرانب ووجدت اختلافات بسيطة ولكن معنوية فى درجة حرارة الجسم واختلافات كبيرة معنوية فى سرعة التنفس وسرعة النبض .

وباستعمال ألوان متباينة لسلالة واحدة من أرانب سدس هى الأبيض والبنى والطوبى أمكن الحصول على اختلافات معنوية عالية للظواهر الفسيولوجية المختلفة وهى درجات حرارة الجلد والشعر وحيوان الأذن وسرعتى التنفس والنبض فيما عدا درجة حرارة الجسم فلم تكن الفروق المتحصل عليها بين هذه الألوان معنوية . وباستمرار كانت الأرانب ذات اللون الطوبى تعطى لأعلى القيم بينما أعطت الحيوانات ذات الفراء البنى أقل القيم وقد يرجع السبب فى ذلك الى أن الحبيبات الداكنة فى الفراء البنى تسهل عمليات تبادل الحرارة .

اختلاف الأعمار تسبب فى حدوث اختلافات قليلة ولكنها معنوية فى قيم جميع الظواهر الفسيولوجية المدروسة فيما عدا درجة حرارة الجلد. ولوحظ نقص طفيف فى درجة حرارة الجسم وسرعتى النبض والتنفس لتقدم العمر وكانت درجة حرارة صوان الأذن فى الأرانب الصغيرة أقل من المتقدمة فى العمر نتيجة لرقة سمك الجلد المغطى بطبيقة من الفراء تكون أقل كثافة فيها فى الحيوانات الكبيرة .

لم يكن للجنس أى تأثير معنوى على درجة حرارة الجسم أما درجة حرارة الجلد فى الظهر فكانت أقل فى الذكور عنها فى الأناث نتيجة لزيادة سمك العضلات والجلد فى هذه المنطقة فى الذكور الى جانب الغطاء السميك من الشعر فى الأناث الذى يحتفظ بكمية أكبر من الحرارة . وقد لوحظ اختلافات طفيفة ولكنها غير معنوية فى درجات حرارة صوان الأذن كما أن سرعة التنفس كانت أعلى فى الأناث عنها فى الذكور .

الحالة الفسيولوجية للأنثى كان لها تأثير معنوى على سرعة التنفس ولكنها لم تكن معنوية التأثير بالنسبة لدرجة حرارة الجسم وسرعة النبض والحيوانات الغير حوامل أظهرت أعلى درجات حرارة للجسم تليها الحديثة الحمل ثم الأناث الحوامل المرضعة وتليها الحيوانات المتقدمة الحمل وكانت سرعتى التنفس والنبض أعلاها فى الأناث المرضعة تليها المتقدمة الحمل هذا بينما كانت الأناث الجلد ذات موقف خاص حيث كانت سرعة تنفسها عالية وذلك بسبب نشاطها العضلى الكبير .