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Environmental factors affecting pre-weaning mortality of Turkish Saanen kids

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Abstract

One of the most important problems encountered in breeding Turkish Saanen goats, the dominant dairy goat in Turkey, is the death of kids. Deaths cause serious economic losses and jeopardize the need for qualified breeders. This study aimed to determine the factors that affected the survival of kids in the period between birth and weaning, when most deaths are observed. A total of 3343 records of Turkish Saanen kids were collected in 2019. The importance and order of the effects of environmental factors, such as gender, birth type, sex, birth weight, farm, season of birth, weight at death, and maternal age at the kid's mortality were determined by using the decision tree statistical method. As a result of this study, the farm effect was the first effective factor in the survivability of kids, and death was less common in small farms (F3), with a rate of 7.8%. The death times of kids were divided into four groups: birth–first 24 hours (M1), 1–7 days (M2), 7–30 days (M3), and 30 days–weaning (90 days) (M4). Deaths were highest in M2 with 40.1% and least in M3 with 5.7%. The death weight variable had a primary effect on deaths. This was followed by birth weight, then farm variables. Two other factors came to the forefront to increase the survivability of the kids: deaths could be greatly reduced by providing good nutrition to the mothers in the prenatal period and offering good management, especially in the first week after birth, to obtain offspring with higher birth weights.

Keywords: decision trees, environmental factors, pre-weaning mortality, Turkish Saanen kids
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Introduction

Goats are a preferred species to meet protein needs, especially for milk and other products. Their number is increasing in the world, owing to their high environmental resistance in limiting conditions (FAOSTAT, 2020). The introduction of several goat breeds in Turkey in the last decade has contributed to improvement in the productivity of indigenous breeds. The Turkish Saanen goat was obtained by crossing hair goats, the dominant domestic goat breed of Turkey, and the Saanen, which was brought to Turkey about half a century ago. It is grown widely as a highly productive, milk goat genotype (Savaş, 2007), especially in Western Anatolia. Although Turkish Saanen kids are regarded as milk-yield oriented, male kids are generally marketed for meat. Breeding sales for these are higher than other goat breeds.

Generally, economic success in goat breeding is measured by the number of kids grown per parent goat per year. Low survivability of kids is a significant problem in goat breeding in Turkey. Although it is acceptable to have 5% total kid mortality on an ideal farm, in practice this value can vary between 10% and 80% and the average is between 32% and 40% (Peeler & Wanyangu, 1998; Ameh *et al*., 2000; Kritas *et al*., 2003; Donkin & Boyazoglu, 2004; Sebei *et al*., 2004; Chauhan, 2019; Al-Khaza'leh *et al.,* 2020; Oderinwale *et al.,* 2020; Kumar, 2021; Roy *et al., 2022*). Mortality, in terms of time frame, can be classified as embryonic, foetal, perinatal, and postnatal (Sebei *et al*., 2004; Otma & Osakwe, 2008).

Mortality in the embryonic and foetal periods is the result of heritability, inability of the fertilized egg to attach to the uterus, insufficient size of the corpus luteum because of a luteinising hormone deficiency, insufficiency of progesterone and nutrition, and inadequate nutrition of the mother, especially in the last month of pregnancy (Çam *et al*., 2002; Sebei *et al*., 2004; Otoikhian *et al*., 2013). The effects of heredity and environmental factors on mortality in the embryonic and foetal periods, and the effects of environmental factors on postnatal deaths are significant (Sebei *et al*., 2004; Otoikhian *et al*., 2013). Viability of the kids, hereditary and maternal causes, birth weight, sex, birth type, nutrition, season and year of kidding, milk production of mothers, farm conditions, anomalies, pathological findings (such as circulatory system disorders, enzyme activities in tissues, disease-causing microorganisms, and factors such as infectious

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diseases) have all been identified as factors (Agüello *et al*., 2004; Agyei *et al*., 2004; Sebei *et al*., 2004; Givens & Marley, 2008; Otuma & Osakwe, 2008; Otoikhian *et al*., 2013; Al-Khaza'leh *et al.,* 2020; Roy *et al.,* 2022). Besides disease, environmental factors have a significant effect of more than 15% on the mortality rate (Hailu *et al*., 2006). Birth weight, birth year, lactation period, birth type, sex, and fertility affect the viability of kids in the pre-weaning period. According to Al-Najjar *et al*. (2010), parity and year of birth have a significant effect on the kid mortality of Shami goats. Mortality rates are affected by environmental conditions, but can be reduced with good standards of care.

Studies have shown that high mortality rates in kids greatly reduces the efficiency and profitability of an enterprise (Shomo *et al.,* 2019; Al-Khaza'leh *et al.,* 2020). For this reason, more detailed studies are needed to determine the impact of environmental factors on the viability of kids, and the character and summation of these effects. In this study on the death of Turkish Saanen kids during the birth-weaning period at four time intervals, the aim was to determine the effects of environmental factors, gender, birth type, sex, birth weight, farm, season, weight at death, and maternal age, and rank them to identify the necessary interventions to be carried out more carefully.

Materials and Methods

The study was conducted with Turkish Saanen kids at İzmir, Turkey. All kids were weighed within 12 hours of birth, using a weighing scale from 0 to 20 kg and reading to 0.1 kg. The kids were weighed again individually at 30, 60, and 90 days old. They were ear tagged at birth, and the birth date, type of birth, and gender were reported. Kid mortality was recorded as the number of kids born dead or alive, and those dying within 90 days post-kidding. A total of 3343 records of Turkish Saanen goat kids were collected in 2019. The times of death were divided into four periods: birth to first 24 hours, 1–7 days, 8–30 days, and 31 days to weaning (90 days).

In the study, farms were selected with intensive breeding and the same kid rearing methods. The total number of animals and the number of caretakers on the farms differed. The management and feeding conditions of the goats were not interfered with. Newborn kids suckled their mothers for two days, were fed with milk between two and ten days of age, and with formula until the weaning period. The kids were allowed *ad libitum* access to water from birth until weaning and were given free access to feed concentrates and roughage. The farms were divided into three groups according to the number of goats: small farm (F3) (≤ 100-head), medium-sized farm (F2) (101–500-head), and large farm (F1) (≥ 501-head).

A multinomial logistic regression equation to predict the likelihood of mortality at birth and the causes of death was compared with 'other cause' mortality. The independent variables were time of mortality, sex, type of birth, birth weight, farm, season of birth, mortality weight, and age of dam (Table 1) The multinomial logistic regression is an appropriate statistical model when the dependent variable has nominal outcomes, and shows better statistical interpretation for complex results. Data were analysed using IBM SPSS v25.

Table 1 Factors affecting kid mortality from birth to weaning (90 d)

Influencing factors						
Time of mortality	M1 Birth–first 24 hours		M2 1–7 days	M3 7–30 days	M4 30 Day–Weaning (90 d)	
Sex	Female			Male		
Type of birth	1		2		3	
Birth weight, kg	BW1: 1600–2500		BW2: 2500–3000	BW3: 3000–3500	BW4: 3500–4000	
Size of farm	F1: large farm (≥501 head)		F2: medium farm (101–500 head)		F3: small farm (≤100 head)	
Season of birth	S1: Autumn		S2: Winter		S3: Spring	
Mortality weight, kg	MW1 1600–2800	MW2 2800–3500	MW3 3500–6000	MW4 6000–8000	MW5 8000–11000	MW6 11000–15000
Age of dam, year	2		3	4	5	6

BW: birth weight; MW: mortality weight

Decision trees were the most appropriate statistical method for the dataset to rank the effects of environmental factors and determine the priority factors causing the deaths. A decision tree is a machine learning technique, in which data are divided continuously according to a parameter. A regression tree is a classification method in decision trees (Breiman *et al*., 1984). In the classification and regression tree (CART) method, independent variables that affect the dependent variables are divided into two homogeneous groups. In this method, the effect is determined using the improvement coefficient. This coefficient decreases as the tree structure changes from top to bottom. This value has no lower or upper limits. The CHAID algorithm (chi-squared automatic interaction detection) is a sub-analysis within the classification and regression tree method (Albayrak & Kotlan-Yılmaz, 2009). The most important difference between CHAID and other decision tree methods lies in the tree species. CARD is derived from binary trees. CHAID analysis is derived from multiple trees (Türe *et al*., 2009) and can provide normality and homogeneity in the distribution of data. In addition, continuous and categorical data can be included in the model at the same time by CHAID analysis (Doğan, 2003; Saraçlı *et al*., 2006; Kayri & Boysan, 2007; Koyuncugil & Özgülbaş, 2008), which also tests relationships between variables (Kayri & Boysan, 2008). If the dependent variable is categorical, the relationship between the variables is tested using chi-square analysis and the dependent variable using the F-test. The dependence between the variables is examined using these tests (Kayri & Boysan, 2007; Erbaş & Güneş, 2010).

Results and Discussion

Table 2 shows the weight, sex, and birth-type averages of Turkish Saanen goat kids from birth to weaning

Table 2 Descriptive statistics of growth performance of Turkish Saanen kids

Item	Birth weight, kg		30-day weight, kg		60-day weight, kg		90-day weight, kg	
	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum
	1.2	6.0	3.2	14.7	4.5	26.6	7.1	38.5
Sex	Frequency,%	Mean	Mean		Mean		Mean	
Female	55.6	3.2 ± 0.6	7.2 ± 1.5		11.4 ± 2.8		16.2 ± 3.9	
Male	44.4	3.5 ± 0.6	7.8 ± 1.6		12.3 ± 3.1		17.7 ± 3.9	
Type of birth	Frequency,%	Mean	Mean		Mean		Mean	
1	24	3.3 ± 0.6	7.7 ± 1.6		12.1 ± 3.0		17.3 ± 4.1	
2	61	3.4 ± 0.7	7.5 ± 1.5		11.8 ± 3.0		16.8 ± 3.9	
3	15	3.4 ± 0.6	7.6 ± 1.5		11.9 ± 2.9		17.0 ± 3.9	

The average birth weight of Turkish Saanen kids was 3.3 kg, which was consistent with the reports of other researchers (Şengonca *et al*., 2003; Şimşek & Bayraktar, 2006; Tülü & Savaş, 2012; Akbaş *et al*., 2013). Birth weight is substantially affected by genotype, birth type, maternal age, and year (Şengonca *et al*., 2003; Şimşek *et al*., 2007; Ceyhan & Karadağ 2009; Bolacalı & Küçük 2011; Yılmaz *et al*., 2013; Tozlu Çelik & Oflaz, 2018).

In the current study, the average live weights of the kids at 30, 60, and 90 days of age were 7.5, 11.8, and 16.8 kg, respectively. Tülü & Savaş (2012) reported a weight of 10.0–10.7 kg in 60–78-day-old kids; Akbaş *et al*. (2013) determined that at days 30, 60, and 90, males and females weighed 7.92–7.86 kg, 11.39–10.82 kg, and 15.35–14.60 kg, respectively. Saanen x hair hybrid goats were 14.1–15.6 kg at weaning, Hair goats are 11.8–12.1 kg at 60 days (Şengonca *et al*., 2003; Şimşek & Bayraktar, 2006), and Damascus goats are 9–10 kg at 60–90 days old (Keskin & Gül, 2006). The results of the current study were higher than Turkish domestic genotypes and similar to the dairy types reared in the world.

In the current study, eight environmental factors that could affect the death of Turkish Saanen goats were modelled in a regression tree. The level of significance of these factors on the survivability of all kids is shown in Figure 1 and for deceased kids in Figure 2.

However, according to the decision tree statistical method, season of birth, type of birth, and sex environmental factors were not included in the analysis results, because they were not primary factors in the kid mortality rate. Hailu *et al*. (2006) stated that kidding in the early dry season (September–November) had the highest mortality rate of 42%. The year of kidding had a significant effect on the death of the kid at birth, but no effect on the mortality rate from birth to weaning (Chawla *et al*., 1982; Gebrelul *et al*., 1994; Şengonca *et al*., 2003; Mtenga *et al*., 2004; Hailu *et al*., 2006). Genotype, disease, climatic conditions, breeding methods, and management systems can affect the mortality rate of the kidding season (Al-Khaza'leh *et al.,* 2020; Roy *et al*., 2022). Some researchers have found that birth type has a significant effect only on kid mortality at birth (Chawla *et al*., 1982; Jan & Gupta, 1993; Gebrelul *et al*., 1994; Miah *et al*., 2002; Mtenga *et al*., 2004; Hailu *et al*., 2006; Gökçe & Erdoğan, 2008; Rojo-Rubio *et al*., 2015). Others have reported that this effect is not significant from birth to weaning (Singh *et al*., 1990; Mandonnet *et al*., 2003; Donkin & Boyazoglu, 2004; Mellado *et al*., 2016). Hussain *et al*. (1995) and Turkson *et al*. (2004) stated that an increase in the multiple birth rate caused an increase in the mortality of the kids. Hailu *et al*. (2006) found that the survivability of kids before weaning was 69% and the survival rate was 70% in single births, which decreased to 43% in multiple births. Tölü & Savaş (2012) found the mortality rate was high in twin kids with low birth weights. The postnatal mortality rate in multiple births may be related to kidding ability and management practices. Although there is the general view that live weight changes starting from birth depend on gender (males are heavier), LW change is affected significantly by factors such as birth type, race, and nutrition. Tozlu Çelik & Oflaz (2018) found the effect of gender was significant in the Saanen x hair goat B2 genotype. According to Mellado *et al*. (2016), gender at birth is not a significant source of variation in weaning weight and pre-weaning daily gain. There is no significant difference in lamb mortality that can be related to litter size and gender (Mellado *et al*., 2016). Although there have been studies that did not detect a significant difference in pre-weaning mortality rates depending on gender (Singh *et al*., 1990; Donkin & Boyazoglu, 2004; Mtenga *et al*., 2004), some report a high and significant relationship between sex and mortality rate (Gebrelul *et al*., 1994; Miah *et al*., 2002).

The post-weaning survival rate of Turkish Saanen kids was 86.4% (Figure 1). This rate was 95.2% in Saanen kids, Teke *et al*. (2011) reported 95.2%, Tölü & Savaş (2012) recorded 88.9–89.7% for two years, and Hailu *et al*. (2006) reported that Borana and Arsi-Bale kids showed an average of 69%.

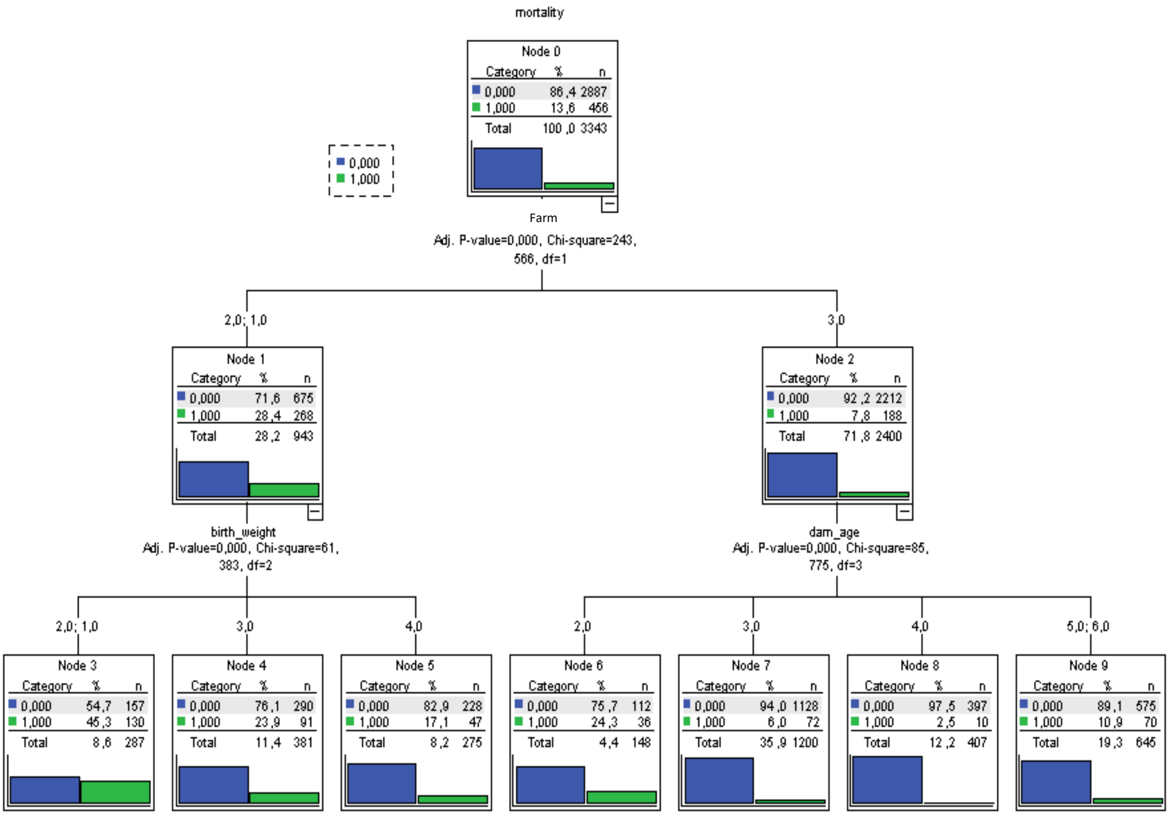

Figure 1 Classification and regression tree (CART) diagram of the independent variables that affect mortality in Turkish Saanen goat kids

In their study on Saanen and local breed goats in South Africa, Donkin & Boyazoglu (2004) determined the average survival rate in all kids as 71%, the lowest value was 39%, and it was 69% in Saanen goats (Tölü & Savaş, 2012).

According to Şengonca *et al*. (2003) and Şimşek & Bayraktar (2006), the effect of genotype and year is significant in the survival rate, which they found was 81.3–95.8% in Saanen × hair hybrid kids. The total mortality rate in Turkish Saanen kids is good compared with many breeds (Mellado *et al*., 2016). The goat-breeding experience and intensive type of farming used by the farmers in the studies might have an effect on this result, such that kid mortality rate might be higher in extensive and semi-intensive herds and may emerge as a serious problem.

The first variable that had an effect on deaths was the number of farmhands. In terms of the number of animals, mortality was 28.4% in large herds (F1 and F2) and 7.8% in small herds (F3) (Figure 2). Although the inadequacy of the keepers is the biggest problem in large herds, in smaller herds, the number of deaths is lower where management conditions are better. Atay *et al*. (2010) found significant differences between businesses in terms of survival and the marketing power of the kids.

In terms of year of establishment, mortality was 28.4% in farms that had been recently established and were thus managed by farmers with less experience in goat breeding (F1 and F2), compared with 7.8% in farms that had been active for a long time (F3) (Figure 2). It has been reported that the differences between farms are caused by methods and conditions, such as herd size, location of the land, cultivation type and direction, nutritional status, preventive health measures, disease control, and control of reproduction (Şimşek & Bayraktar 2006; Tozlu Çelik & Oflaz, 2018, Özyürek *et al*., 2018; Al-Khaza'leh *et al.,* 2020).

Management conditions are not only shaped by the farm but are affected substantially by the farmer's experience of raising animals (Amir & Knipscheer, 1987). As a result of the current study, in which farms were grouped according to the number of herds, the farm was an important factor. The estimation of the needs of animals on farms, and in some cases, the interventions applied, is also shaped by experience, and an important relationship can be established between increased experience and welfare parameters (Devitt *et al*., 2018).

The birth weight variable acted as an important factor for F1 and F2. The death rate was highest in light birth weights (BW1, BW2) at 45.3%; was 23.9% in the middle weight category (BW3); and was 17.1% lower in the heavy weight category (BW4) (Figure 2). In their study on lambs, Mellado *et al*. (2016) determined mortality rates at 54% in those born under 3.5 kg, 29% in those between 3.5 and 4.5 kg, and 9% in those born at more than 4.5 kg. According to Daş *et al*. (2005), the most important predisposing factor for kid mortality is low birth weight. Similar findings by Hailu *et al*. (2006) indicate that the effect of birth weight on mortality is statistically significant and the survival rate is highest in kids with birth weights in the range of 3.1–4.5 kg. Birth weight is a significant factor for kid survivability subsequent growth performance. Low birth weight is affected by birth type, gender, maternal nutritional deficiency, health problems, and various anomalies. In kids with a relatively high birth weight, live weight gain, and weaning weight are also expected to be high (Wollny, 2000).

Although maternal age was an important factor in the mortality of kids in F3, the lowest mortality rate was 2.5% in four-year-old mothers. The highest kid mortality rate was found in two-year-old mothers, at 24.3% (Figure 2). Atay *et al*. (2010) reported the effect of maternal age on fertility and kid mortality and the farm effect on these results. Maternal age has a significant impact on mortality rates at birth and from birth to weaning. Generally, the survival rate of the kids increases with the age of the female. In this sense, the current study concurred with Barding *et al*. (2000) and Mazumdar *et al*. (1980). However, this information was not compatible with the results of Mandonnet *et al*. (2003).

In terms of deceased kids, the highest mortality rate was 40.1% in M2, 28.3% in M4, and 25.9% in M1. The lowest mortality rate occurred in M3, at 5.7% (Figure 2). It is expected that the mortality rate will be higher in the first week of life. Roy *et al*. (2022) determined mortality rates in the first week of birth as 41.98%, then 26.13% in the second week, 18.72% in the third, and 13.17% in the fourth week. Kids become vulnerable at birth. Intake of colostrum during this period is one of the most important factors for survival. Negative conditions of shelter, nutritional and metabolic deficiencies, disease, and weather conditions are among the factors that affect mortality. However, survivability during the transition from weaning to feeding is probably an indication of good management. In the study by Tölü & Savaş (2012), the mortality rates in Turkish Saanen goats were 1.3–3.9% at birth, 4.8–5.2% between birth and weaning, and 3.2–3.9% after weaning. In Saanen and hair goat crosses, the survivability of kids for the weaning period in S × K F1, S × K G1, S × K G2 genotypes was 95.83%, 86.81%, and 71.43%, respectively (Tozlu Çelik & Oflaz, 2018). According to Şimşek *et al*. (2007), the insignificant effect of birth type and maternal age on survivability during the weaning period is consistent with the current research findings. Several researchers have reported that the viability of Saanen × hair goat hybrid kids during weaning is between 81.3% and 95.8% (Şengonca *et al*., 2003; Şimşek & Bayraktar 2006; Şimşek *et al*., 2007; Yılmaz *et al*., 2013). For hair goat hybrid kids and Saanen kids, Taşkın *et al*. (2003) reported 98.4%, Ceyhan & Karadağ (2009) reported 89.6%, and Karakuş (2016) reported 86.4%; the current research findings are similar.

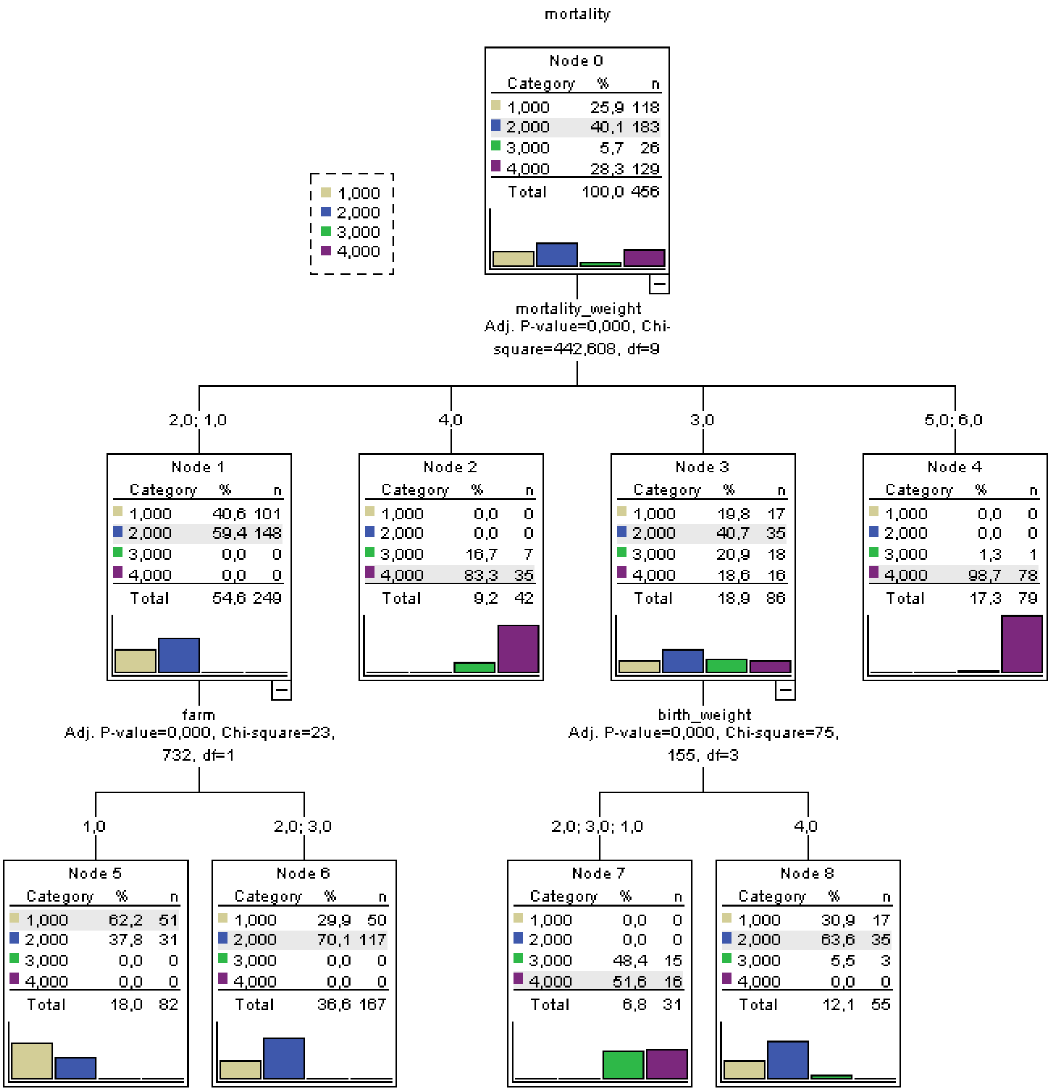

Figure 2 CHAID (chi-squared automatic interaction detection) diagram of the independent variables that affect mortaility in Turkish Saanen goat kids

Weaning periods vary according to breed, region, the kid rearing method, and the purpose and form of rearing. Similar studies were carried out in breeds other than Saanen and their crosses. Hailu *et al*. (2006) determined that the average mortality rate before weaning was 31% in Borana and Arsi-Bale kids. Mortality rate in Damascus goats was 12% at birth, 6.0% at weaning from the fourth day, and 0.6% at weaning (Hailu *et al*., 2006). Mortality at weaning age was observed in African goats and in the lower East, namely 11.3% in West African Dwarf goats (Ikwuegbu & Ofadile, 1994); 32.1% in Indian dairy goats (Chawla *et al*., 1982), 27.2% in Yaez goats (Rattner *et al*., 1994), 29.0% in South African goats (Donkin & Bayozoğlu, 2004), 37% in domestic goats (Sebei *et al*., 2004), and 40.6% (Mtenga *et al*., 2004). Kids are affected more by cold weather conditions in the first weeks after their birth. In this context, improving shelter and care conditions can reduce kid loss (Tozlu Çelik & Oflaz, 2018).

Mortality was affected by the farm factor, MW1–2, which was the lowest, and MW4–5–6, the highest, and MW 3 (3.5–6.0 kg) was affected by birth weight. The death of kids weighing 3.5–6.0 kg usually occurs in the M2 period. According to this result, birth weight appeared to have an effect on mortality. Similarly, in the group with the lowest death weight, the highest death rate was in M2 with 60% (Figure 2). However, it is thought that this was because of the inexperience of the farmers in goat breeding, and there were management errors compared with other farms. The deaths of kids over 6 kg was mostly caused therefore by management errors during the weaning period.

The highest birth weight was in BW4, with the highest mortality rates being within 1–7 days (M2). The mortality rates of kids with birth weights in the BW1, BM2, and BW3 groups were 48.4% and 51.6% in the M3 and M4 periods, respectively, and there was no death before the age of seven days. If kids with a high birth weight survived in the first week following birth (M1, M2), which is the period when they adapt to the environment, their survival rate is higher than those with a low birth weight. No deaths were encountered during the weaning period either. Other groups with low birth weight had the largest rate of deaths during the weaning period, 51.6%. Birth and death rates in the first 24 hours (M1) were the highest in F1 (62.2%), followed by the M2 period (37.8%). In the other periods, no deaths were observed. The mortality rate in F2 and F3 was higher in the M2 (70.1%) than in the M1 (29.9%) period (Figure 2). This may be due to the lack of information on management in farmers, especially in the prenatal and postnatal period.

In small ruminants, the birth is generally not interfered with. In this context, the problem may depend on breeder selection, nutrition, housing conditions and some diseases. On farms with a small herd size, deaths occurring in the M2 period may be caused by first parity of goats and general management errors.

Conclusions

Although all the environmental factors were expected have significant effects on the mortality of Turkish Saanen goats, the influence of farm, birth weight, and maternal age were prioritised, as seen in the CART and CHAID diagrams. Days 1–7 following the birth, the period with the highest mortality rates, were the riskiest days of survival, even for kids with a high birth weight. Weight was the most definitive factor in the deaths of kids. To increase the survivability of the kids, precedence should be given to the nutrition of the does prenatally, to does who are pregnant for the first time, and to a good management of the farm in general. With improvement in environmental factors, which should be regarded as important, the deaths of goats can be prevented to a large extent and the profit margin of the enterprises can be increased.

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Conflict of Interest Declaration

The authors declare that they have no conflict of interest.

References

Agüello, A., Castro N., Capote, J., Tyler, J.W. & Holloway, N.M., 2004. Effect of colostrum administration practices on serum IgG in goat kids. Livest. Prod. Sci. 90, 235-239.

Agyei, A.D., Odonkor, M. & Osei-Somuah, A., 2004. Concurrence of *Eimeria* and helminth parasitic infections in West African Dwarf kids in Ghana. Small Rumin. Res. 51(1), 29-35.

Akbaş, A.A., Çolak, M., Elmaz, Ö. & Saatcı, M., 2013. Determination of growth performance of the Saanen kids reared in north-west Mediterranean condition. Eurasian J. Vet. Sci. 29(2), 70-75.

Al-Khaza'leh, J., Megersa, B. & Obeidat, B., 2020. Constraints and risk factors contributing to young stock mortalities in small ruminants in Jordan. Small Rumin. Res. 183, 106033.

Al-Najjar, K., Salhab, S., Al-Merestanı, R., Kasem, R., Al-Azzawı, W., Dawam, M., Omed, H. & Saatcı, M., 2010. Environmental factors affecting kid mortality in Shami Goats. Journal of the Faculty of Veterınary Medıcıne, Kafkas Unıversıty 16 (3), 431-435.

Albayrak, A.S. & Kotlan-Yılmaz, Ş., 2009. Data mining, decision tree algorithms, and an application on İSE data. Suleyman Demirel University. The Journal of the Faculty of Economics and Administrative Sciences 14(1), 31- 52.

Ameh, J.A., Egwu, G.O. & Tijjani, A.N., 2000. Mortality in Sahelian goats in Nigeria. Prev. Vet. Med. 44, 107-111.

Amir, P. & Knipscheer, H.C., 1987. Application of the environment–behavior–performance model in farming systems research: The case of small ruminant technology transfer. Agricultural Administration and Extension 25(3), 161-176.

Atay, O., Gökdal, Ö. & Eren, V., 2010. Reproductive characteristics and kid marketing weights of hair goat flocks in rural conditions in Turkey. Cuban J. Agricul. Sci. 44, 353-358.

Barding, R.P., Mohite, P.M., Patil, G.R. & Dhoble, R.L., 2000. Effect of season on kidding birth weight and pre-weaning mortality in Osmanabadi goats. 7th international Conference on Goats, 15–21 May 2000, France.

Bolacalı, M. & Küçük, M., 2011. Growth performance and survival sates of Saanen kids raised in Muş province. Iğdır Univ. J. Inst. Sci. & Tech. 1(2), 125-131.

Breiman, L., Friedman, J.H., Olshen R.A. & Stone, C.J., 1984. Classification and regression trees. Chapman & Hall / CRC. https://www.taylorfrancis.com/books/mono/10.1201/9781315139470/classification-regression-trees-leo-breiman

Çam, M.A., Kuran, M., Yıldız, S. & Selçuk, E., 2002. Growth and reproduction and performance in ewes administered GnRH-agonist on day 12 post mating. Anim. Prod. Sci. 7, 73-82.

Ceyhan, A. & Karadağ, O., 2009. Some descriptive characteristics of Saanen goats raised in Marmara Livestock Research Institute, J. Agric. Sci. 15, 196-203.

Chauhan, I.S., Misra, S.S., Kumar, A. & Gowane, G.R., 2019. Survival analysis of mortality in pre-weaning kids of Sirohi goat. Animals 13(12), 2896–2902.

Chawla, D.S., Bhatnagar, D.S. & Mishra, R.R., 1982. Factors affecting kid mortality in dairy goats. Indian J. Anim. Sci. 52, 166-171.

Daş, G., Konyalı, A. & Savaş, T., 2005. İzmir a study on kid mortality in dairy goats. Dairy Goat National Congress, 26–27 May 2005, İzmir, Turkey.

Devitt, C., Hanlon, A., More, S.J., Kelly, P.C. & Blake, M., 2018. Challenges and solutions to supporting farm animal welfare in Ireland: Responding to the human element. Technical Report in Veterinary Medicine Research Collection. https://www.readkong.com/page/challenges-and-solutions-to-supporting-farm-animal-welfare-4543066

Doğan, İ., 2003. Investigation of the factors which are affecting the milk yield in Holstein by CHAID analysis. Veterinary Journal of Ankara University 50(1), 65-70. DOI: 10.1501/Vetfak_0000002231.

Donkin, E.F. & Boyazoglu, P., 2004. Diseases and mortality of goat kids in a South African milk goat herd. S.Afr. J. Anim. Sci. 34, 220-223.

Erbaş, S. & Güneş, A., 2010. Chaid analysis. Statistics Conference Proceedings, Ankara. Çukurova University Journal of Economics and Administrative Sciences 11(2), 51-55.

FAOSTAT, 2020. Live animals. In: FAO Statistical Databases. Food and Agriculture Organization of the United Nations. http://faostat.fao.org.

Gebrelul, S., Sartin, L.S. & Iheanacho, M., 1994. Genetic and non- genetic effects on the growth and mortality of Alpine, Nubian, and crossbred kids. Animal Breed 62, 9.

Givens, M.D. & Marley, M.S.D., 2008. Infectious causes of embryonic and fetal mortality. Theriogenology 70(3), 270-285.

Gökçe, E. & Erdoğan, H.M., 2008. Pneumonia in neonatal lambs: Frequency and some associated risk factors. Journal of the Faculty of Veterınary Medıcıne, Kafkas Unıversıty 14 (2), 223-228. DOI: 10.9775/kvfd.2009.1514

Hailu, D., Mieso, G., Nigatu, A., Fufa, D. & Gamada, D., 2006. The effect of environmental factors on preweaning survival rate of Borana and Arsi-Bale kids. Small Rumin. Res. 66 (2006), 291–294.

Hussain, S.S., Horst, P. & Islam, A.B.M.M., 1995. Effect of different factors on pre-weaning survivability of Black Bengal kids. Small Rumin. Res. 18, 1-5.

Ikwuegbu, O.A. & Ofodile, S., 1994. Wet season supplementation of West African Dwarf goats raised under traditional management in the sub-humid zone of Nigeria. In: S.H.B. Lebbie, B. Rey, E.K. Irungu (eds). Small Ruminant Research and Development in Africa. Proceedings of the African Small Ruminant Research Network AICC, Arusha, Tanzania. 7–11 December 1992. Pp. 179-182.

Jan, I.A. & Gupta, S.C., 1993. Effect of month of birth on mortality of pre weaning kids. Anim. Breed 61, 10.

Karakuş, F., 2016. The effect of body condition score on fertility, live weight and some body measurements in goats. Yuzuncu Yıl Universıty Journal of Agricultural Sciences 26, 372-379.

Kayri, M. & Boysan, M., 2007. Using Chaid analysis in research and an application pertaining to coping strategies. Ankara University, Journal of Faculty of Educational Sciences 40(2), 133-149.

Kayri, M. & Boysan, M., 2008. Assessment of relation between cognitive vulnerability and depression level by using classification and regression tree analysis. Hacettepe University Journal of Education 34, 168-177.

Keskin, M. & Gül, S., 2006. Damascus goat in goat breeding in Hatay and its importance for Turkey. Harvest Livestock 255, 46-49.

Koyuncugil, A.S. & Özgülbaş, N., 2008. Strengths and weaknesses of SMEs traded on the IMKB, CHAID decision tree application. Journal of Economics 23(1), 1-21.

Kritas, S.K., Burriel, A.R., Tzivara, A.H., Govaris, A., Kyriakis, S.C., Karatzias, H. & Vlemmas, J., 2003. Prevention of scours in neonatal kids after modification of management and experimental vaccination against *Escherichia coli*. Small Rumin. Res. 50, 51-56.

Kumar, N., Kumari, N. & Shrivastava, A.K., 2021. A study of effect of sex, season, type, and parity of birth on absolute and relative body weight of Black Bengal goats at different ages under farm condition of management. J Entomol Zool Stud. 9(1), 197–201.

Mandonnet, N., Ducrocq, V., Arquet, R. & Aumont, G., 2003. Mortality of Creole kids during infection with gastrointestinal strongyles: A survival analysis. J. Anim. Sci. 81, 2401-2408.

Mazumdar, N.K., Mazumdar, A. & Goswami, K.K., 1980. Studies on some factors affecting mortality and survival rates in Pashmina kids. Indian J. Anim. Sci. 50, 251-255.

Mellado, M., Macías, U., Avendaño, L., Mellado, J. & García, J. E., 2016. Growth and pre-weaning mortality of Katahdin lamb crosses. Rev Colomb Cienc Pecu 29, 288-295.

Miah, G., Husain, S.S., Hoque, M.A. & Baik, D.H., 2002. Effect of genetic and non-genetic factors other than disease on kid survivability in goats. J. Anim. Sci. Technol. (Korean), 44, 271-278.

Mtenga, L.A., Kifaro, G.C. & Belay, B., 2004. Studies on the factors affecting reproductive performance and mortality of Small East African goats and their crosses. In: B.H. Ogwarg, D. Marimbela, R. Vilakati, G.Z. Khumalo (ed.) Small

Ruminant Research and Development in Africa. Socio-economic aspects of goat nutrition in Swaziland. Proceedings of the 2nd Biennial Conference of the African Small Ruminant Research Network. AICC, Arusha, Tanzania. 7–11 December 1992. Pp. 69-74.

Oderinwale, O.A., Oluwatosin, B.O., Onagbesan, M.O., Akinsoyinu, A.O. & Amosu, S.D., 2020. Performance of kids produced by three breeds of goat fed diets supplemented with graded levels of turmeric powder. Trop. Anim. Health Prod. 52, 1239–1248.

Otoikhian, C.S.O., Orheruata, A.M. & Utulu, G., 2013. Influence of birth weight on weight-gain and milk-intake of wad goat kids within first 25 days of life. IJSID 3, 555–557.

Otuma, M.O. & Osakwe, I.I., 2008. Assessment of the reproductive performance and post weaning growth of crossbred goat in Derived Guinea Savanna Zone. Res. J. Anim. Sci. 2, 87–91

Özyürek, S., Türkyılmaz, D., Dağdelen, Ü., Esenbuğa, N. & Yaprak, M., 2018. Research on structural characteristics and problems of sheep breeding according to farmer size in Erzincan. Academic Journal of Agriculture 7(2), 219-226, ISSN: 2147-6403 DOI: http://dx.doi.org/10.29278/azd.476651

Peeler, E.J. & Wanyangu, S.W., 1998. Infectious causes of small ruminant mortality in Kenya: A review. Small Rumin. Res. 29: 1-11

Rattner, D., Riviere, J. & Bearman, J.E., 1994. Factors affecting abortion, stillbirth, and kid mortality in the goat and yaez (Goat × Ibex). Small Rumin. Res. 13(1), 33-40.

Rojo-Rubio, R., Kholif, A.E., Salem, A.Z.M., Mendoza, G.D., Elghandour, M.M.M.Y., Vazquez-Armijo, J. F. & Lee-Rangel, H., 2015. Lactation curves and body weight changes of Alpine, Saanen, and Anglo-Nubian goats as well as pre-weaning growth of their kids. J. Appl. Anim. Res. 44(1), 331–337. http://dx.doi.org/10.1080/09712119.2015.1031790.

Roy, R., Tiwari, R., Dutt, T., Pal, P.K. & Majumder, D., 2022. Pre-weaning kid mortality under family-based farming system: Patterns and economic losses in different agro-climatic regions of West Bengal, India. Indian J. Anim. Sci. 92 (3), 394–397.

Saraçlı, S., Doğan, İ., Kaygısız, Z. & Kaya, M., 2006. Examining the student's department satisfactions at Osmangazi University and Faculty of Economics and Administrative Sciences, Eurasian Journal of Educational Research 22, 179-187.

Savaş, T., 2007. Raising a lamb. A review on the trouble spots. J. Anim. Prod. 48(1), 44-53.

Sebei, P.J., McCrindle, C.M.E. & Webb, E.C., 2004. Factors influencing weaning percentages of indigenous goats on communal grazing. S. Afr. J. Anim. Sci. 34 (Supplement 1), 130-133.

Şengonca, M., Taşkın, T. & Koşum, N., 2003. Simultaneous comparison of various production traits of Saanen x hair crossbred and pure hair goats. Turk. J. Vet. Anim. Sci. 27, 1319-1325.

Şimşek, Ü.G. & Bayraktar, M., 2006. Investigation of growth and survivability characteristics in hair goats and Saanen x hair goat crossbreeds F1. Fırat University, Journal of Health Sciences, 20(3), 229-238.

Şimşek, Ü.G., Bayraktar, M. & Gürses, M., 2007. Investigation of growth and survivability characteristics in Saanen x pure hair goats crossbreeds F1 and B1. Fırat University, Journal of Health Sciences 21(1), 21-26.

Singh, D.K., Mishra, H.R. & Singh, C.S.P., 1990. Genetic and non-genetic factors affecting pre-weaning survivability in kids. Anim. Prod. 51, 559-564.

Taşkın, T., Demirören, E. & Kaymakçı, M., 2003. The efficiency and productivity of kid production in Saanen and Bornova Goats. Journal of Agricultural Faculty of Ege University 40, 33-40.

Teke, B., Akdağ, F. & Arslan, S., 2011. Some fertility, growth and behavioral traits of Saanen Goats raised on private farm condition. Journal of the Faculty of Veterinary Medicine, Istanbul University 37(1), 1-8.

Tölü, C. & Savaş, T., 2012. Comparison of Gökçeada, Maltese and Turkish Saanen Goat genotypes in terms of birth and growth. J. Anim. Prod. 53(2), 17-25.

Tozlu Çelik, H. & Olfaz, M., 2018. Investigation on survival rate and growth characteristics of pure hair goat and Saanen x hair goat (F1, B1, B2) crossbreds in breeder conditions. Mediterr. Agric.Sci. 31(1), 77-85.

Türe, M., Tokatlı, F. & Kurt, Ü., 2009. Using Kaplan-Meirer analysis together with decision tree methods (C&RT, CHAID, QUEST, C4.5 and ID3) in determining recurrence-free survival of breast cancer patients. Expert Systems with Applications 36(2), 2017-2026.

Turkson, P.K., Antiri, Y.K. & Baffour-Awuah, O., 2004. Risk factors for kid mortality in West African Dwarf goats under an intensive management system in Ghana. Trop. Anim. Health Prod. 36, 353-364.

Wollny, T., 2000. Mutterlose Aufzucht von Heidschnuckenlämmern unter besonderer Berücksichtigung der Anwendung eines Tränkeautomaten. Inaugural Dissertation zur Erlangung des Grades eines Doctor Medicinae Veterinariae durch die Tierärztliche Hochschule Hannover.

Yılmaz, O., Küçük, M., Bolacali, M. & Çak, B., 2013. Investigation of survival rate, growth performance and some body measurements of Saanen x hair goat F1 crossbred and pure Hair goat kids raised in semi-intensive conditions. Bulgarian J. Agricultural Sci. 19, 835-840.