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Kid mortality indicators based on census data in dairy goat herds in the Netherlands

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ABSTRACT

Optimal young stock rearing benefits animal health and welfare and therefore contributes to a more sustainable herd. In order to be able to evaluate the rearing process, producers need insight into their kid rearing results, preferably based on key indicators. Although mortality is considered a useful parameter to assess animal health and welfare, little is known about the prevalence and factors influencing mortality in dairy goat farming. Calculating kid mortality risks may be further challenged by how and when producers record mortality after birth. This study aimed to develop key kid mortality indicators which can support producers in optimising their rearing system. Census data were available from 395 Dutch dairy goat herds from 2016 until and including 2020. Four mortality indicators were defined: mortality risk of neonatal kids, and mortality rates of postnatal, preweaning, and postweaning kids. Mortality percentages were determined for three subgroups of dairy goat herds depending on the quality of available data i.e. accuracy and completeness of data. The quality of mortality data was classified as good in 39 % (n = 153), fair in 49 % (n = 192), or poor in 13 % (n = 50) of the included herds. For each of the three quality groups, recorded kid mortality for all four mortality indicators was higher in herds with accurate animal registration. Kid mortality was significantly different (p 0.001) between all quality groups. Other factors affecting kid mortality levels included herd size as the 25 % largest herds had lower kid mortality (p = 0.005), and a decreasing trend was associated with the age of dairy kids. This study provided insight into kid mortality in Dutch dairy goat herds and showed that it is possible to monitor kid mortality based on routinely collected data. Nevertheless, data quality should be considered when communicating benchmark values and individual results back to farmers. It is therefore recommended that benchmark values are calculated on data from herds with the highest data quality.

1. Introduction

Raising goat kids is inextricably linked to dairy goat farming, not only because gestation is necessary to start lactation, yet equally for herd replacement and improvement of herd genetics. Since dairy goats are seasonal breeders, producers have to deal with a short time frame in which farm activities are dominated by kidding and rearing of new-born young stock. In Dutch dairy goat farming, it is customary to aim for prolonged lactation, therefore generally only a small part of the herd gives birth to kids of which the majority is born between January and May (Dijkstra et al., 2023). Nevertheless, an increasing number of dairy goat farmers opt for multiple kidding periods not only to spread workload but also as a management tool to decrease disease burden. Doe kids are generally raised as replacement production animals, whereas, with the exception of breeding stock, male kids are sold at very young age for pet food production or are fattened on the farm of origin (Meijer et al., 2021).

Optimal young stock rearing will result in highly producing and resilient dairy goats, and minimizes losses of kids and therefore increases revenues. Additionally, optimisation of kid rearing is no longer only in the interest of farmers, but increasingly has become a sociopolitical topic for most livestock industries in the Netherlands, including the dairy goat industry (Berg et al., 2020). Additionally, in the context of increasing public attention for sustainable livestock farming and the environment, optimising young stock rearing and thereby reduction of both antimicrobial use and kid mortality are considered increasingly important. Extra attention is paid to male kids as costs for housing, veterinary care, and slaughter are often considered

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compromised investments (Meijer et al., 2021).

In an effort to lower mortality, improvement of kid rearing should not be seen as an one-size-fits-all approach, but should be tailored to each unique herd (Dwyer et al., 2016). In order to be able to evaluate the rearing process for potential weaknesses, producers need to have insight into their kid rearing results, preferably based on automatically generated key indicators. Providing herd-specific insight through routine feedback on mortality and rearing figures, complemented by a benchmark, has proven to support and motivate livestock farmers to improve their calf rearing (Santman-Berends et al., 2018). Since the implementation of KalfOK, a voluntary young stock rearing quality system, in 2018, a clear decrease in calf mortality has been observed in Dutch dairy cattle herds (Santman-Berends et al., 2021). Insight provided by such a program supports farmers and veterinarians with essential information to plan an approach and implement specific measures that are necessary to further reduce calf mortality.

Although mortality is considered a useful parameter to evaluate animal health and welfare, both literature and reliable figures regarding early mortality of dairy goat kids are lacking, complicating the assessment and (inter)national cross-comparison of kid rearing results (Ortiz-Pelaez et al., 2008; Ouweltjes et al., 2020; Santman-Berends et al., 2014). Also, on-farm record keeping is generally rudimentary and limited to the legally required identification and registration (I&R) (Commission Regulation (EC) No. 21/2004, 2004). Accurate determination of early mortality is therefore challenging and should preferably be based on routine census data (Ortiz-Pelaez et al., 2008; Santman-Berends et al., 2014). Since 2010, all goats in the Netherlands must be provide with an electronic ear tag and registered in a central database before six months of age or when leaving the farm of birth. This I&R database is established to monitor individual animal movements and track them when required. Mortality on goat farms is analysed annually based on I&R and rendering data as part of the monitoring and surveillance system of animal health in the Netherlands (Dijkstra et al., 2022). However, these results are not suitable for rearing assessment as they report an overall mortality rate of registered goats in individual herds and do not provide accurate information on the mortality of kids under twelve months of age. Calculation of kid mortality requires earlier, more uniform and detailed data (Dijkstra et al., 2023).

In 2017, Royal GD (GD, Deventer, the Netherlands) performed a preliminary analysis of goat kid mortality at the request of the Dutch dairy goat industry, using anonymised I&R data. Survival percentages of dairy goat kids up to six months old varied between 61.9 and 100 per cent, with an average of 93.3 per cent (Santman-Berends and Vellema, 2017). Kids that died before registration in I&R would not be counted as dying and therefore underestimate mortality (Santman-Berends and Vellema, 2017). It is hypothesised that producers that register kids immediately after birth will have higher registered mortality compared to producers that postpone kid registration, and only register kids that survive the first days or even weeks. This bias in registration might hinder a fair cross-farm comparison of rearing results.

The main objective of this study was to generate a number of key rearing performance indicators which can support dairy goat farmers in the Netherlands in reducing kid mortality. Therefore, an in-depth analysis was performed on I&R data to gain more knowledge about kid mortality on dairy goat farms and the influence of registration bias on these indicators.

2. Materials and methods

2.1. Study population and available data

This study was conducted on dairy goat census data which included data from all 444 dairy goat herds that delivered milk for at least one month during the study period from 1 January 2016–31 December 2020. From all herds, animal movement data were available from RVO (Rijksdienst voor Ondernemend Nederland, Netherlands Enterprise Agency, Assen), and herd type data were available from GD. The I&R data included unique herd identification (UHI) and animal identification (animal ID) numbers, and movement data including date, location (UHI) and reason of movement: on-farm through birth, purchase or import; off-farm through sale, export, slaughter or death. GD provided data to identify all dairy goat herds based on their customer relationship management system (CRM) combined with records on participation in bulk milk health schemes.

2.2. Definitions

In this study, the kid rearing period is defined as the period between birth and six months of age, and is divided into four periods of interest i.e.

1) neonatal period: birth to 7 days old;
2) postnatal period: 8–21 days old;
3) preweaning period: 22–49 days old;
4) postweaning period: 50 days until 6 months old.

Similar periods were used for calculation of calf mortality indicators in the Netherlands (Santman-Berends et al., 2019).

The neonatal period is defined as the period from birth up to seven days of age, similar to the definition used by RVO. During this period, dairy goat farmers are not allowed to move kids off-farm, and it is therefore justifiable to calculate a mortality risk instead of mortality rate. For this parameter, the number of registered deceased kids from birth to seven days of age ($n\_dead_{\leq 7days}$) is included as numerator and divided by the total number of registered kids ($n\_registered$) (formula 1). The mortality risk is subsequently presented as percentage.

$$Pmortality\_risk_{<7days} = \frac{n \quad death_{\leq 7days}}{n \quad registered} * 100\% \tag{1}$$

The other three mortality indicators, postnatal kid mortality, preweaning kid mortality and postweaning kid mortality are all calculated in an age period in which kid movements are allowed. Therefore, mortality rates were chosen as the best indicator for mortality. Compared to mortality risk, a mortality rate includes the days at risk, i.e. the number of days that a kid is present in the herd. These mortality rates are calculated according to formula 2.

$$Pmortality\_rate_{period} = \frac{n \quad death_{period}}{n \quad registered_{period} * Time \quad at \quad risk_{period}} * 100\% \tag{2}$$

For each herd and for each predefined age period (*period*), the numerator and denominator are calculated per year during the whole analysed period.

2.3. Data validation and analyses

Due to privacy regulations, and to prevent traceability of results to individual herds or animals, all datasets were encrypted by an external encryption company (IntoFocus Data Transformation Services, IDTS, Deventer) before being provided to GD. IDTS encrypted all variables in the data containing information traceable to the original source, such as UHI or animal ID. To ensure that data from different organisations could be combined for analysis, a corresponding encryption code was used for all data sets.

Standard software scripts in SAS 9.4® (SAS Institute Inc., 2013) were developed to automate the validation process and to combine the data sets. All data were checked for duplicates and inconceivable or (biologically) unlikely values. After validation, the data was transferred to Stata® (StataCorp, 2019) for further analysis. Descriptive statistics for herd-level demographics were generated from the dataset as a whole and mortality results were generated after further classification of the herds according to data quality.

2.4. Stratification of dairy goat herds based on registration quality

To be able to correct for possible influences of completeness and quality of registration of kid mortality, all dairy goat herds were stratified to one of three subgroups with high, average and poor assumed registration quality. Allocation to these groups was based on a pre-analysis data quality check and expert elicitation. An expert group was formed of three veterinary specialists in small ruminant health affiliated with Royal GD. Based on available data, three parameters were evaluated to indicate the completeness and quality of data: i) difference between expected and observed birth patterns, ii) time until registration of new-born kids and iii) biologically implausible kid mortality rates.

2.4.1. Birth patterns

Expert elicitation learned that not all farmers register their new-born kids on a daily basis. To confirm that presumption, the number of birth registrations per day of the week was determined. From a biological perspective, we can assume that goat kids have an equal probability to be born on each day of the week and month i.e. the number of births on the first day of the month is expected roughly similar to the number of births on each other day of that same month. So, one could expect that on every day of a month with 31 days, regardless of the year, approximately 3.23 % of the kids are born, and the observed distribution of births should be very close to the expected uniform distribution of 3.23 % of births per day. Small differences would indicate daily and precise registrations, while large differences indicate inaccurate and possible incomplete registrations. For each of the included dairy goat herds, observed birth patterns were evaluated during the whole analysed period by summing the total number of registered births per day of month during the five-year period divided by the total number of births in the same period. The observed percentage of registered births per herd per day of the month was subsequently normalised to 31 days i.e. we corrected for the fact that goat kids were less likely to be born on day 29, 30 and 31 given that not all months include these days.

For each included dairy goat herd, we subsequently calculated the average absolute difference between the expected 3.23 % births per day of month and the observed distribution. Based on the results, each herd was classified in one of four groups. Each group contained approximately 25 % of the included herds: group 1 contained the 25 % with the smallest deviations between expected and observed birth patterns, whereas group 4 contained the 25 % with the largest deviations.

2.4.2. Time between birth and registration in I&R system

It was assumed that registration immediately after birth is associated with more complete data and a higher data quality and therefore this criterion was included in the quality allocation of dairy goat herds. For each herd, the interval in days between the date of birth and date of registration in I&R was calculated at individual animal level and aggregated into a median interval per herd per year.

Based on the interval results over five years, herds were classified in one of three groups after comparing the herd specific interval median with the overall study median. Herds with an interval below the median value in all five years were classified as "fast registration", with an interval above the median in all five years as "slow registration", and all remaining herds were classified as "varying speed of registration".

2.4.3. Reliability of reported mortality

Based on expert opinion of small ruminant specialists of GD, an unreliable mortality was defined as kid mortality rates below 1 % in the first six months of age over a multiple year period. Herds that complied with this definition were assigned to the category "unreliable mortality".

2.4.4. Overall classification

Each dairy goat herd subsequently received an overall quality classification based on the combination of the assessment of birth patterns, the time between birth and registration, and reliability of mortality data. First, goat herds with an unreliable low kid mortality based on their registered data were classified as having a low data quality. The remaining herds were classified as either having a fair or good data quality based on the birth patters and time between births and registrations (Fig. 1).

2.4.5. Association between kid mortality and herd characteristics

To examine the association between kid mortality on dairy goat farms and herd characteristics, data were allocated as time-series data with repeated observations per farm in time (year). Analysis were performed using a negative binomial multivariable regression model with a log link function in which the number of kids that died within the first six months of life was included as dependent variable. The number of kids at risk of dying on farm was included as an exposure variable. Three independent categorical variables were included as independent variable, indication for quality of registration, year (2016–2020), and month in which the birth peak occurred. This month was defined by the highest percentage of birth registrations. For all three variables, the average of all included herds was used as reference category.

3. Results

3.1. Population

Out of the 444 dairy goat herds that produced milk in at least one month between 2016 and 2020, 395 were still producing at the end of 2020. Of the remaining 49 herds, 11 herds became small scale herds, and 38 had stopped. Data from these 49 herds were omitted from further analyses.

Between 2016 and 2020, data were available from 2,053,113 goats registered at 395 dairy goat herds. Average herd sizes fluctuated throughout the year, with generally most goats being registered in April at the end of the kidding period, and the least in December prior to the kidding season (Fig. 2). Over time, the average herd size increased from 1140 goats over 1 year of age in 2016–1333 goats in 2020. The median number of goats per herd remained considerably lower with 976 goats in 2016 and 1091 goats in 2020 (Fig. 2).

Fig. 3 shows the number of registered births per day in dairy goat herds between 2016 and 2020. During the analysed period, on average 327,511 kids were registered per year in the I&R data base, and most kids were born between January and April. From 2018, a second but smaller peak is visible in autumn, causing the peak in spring slightly to decrease.

3.2. Kid mortality indicators

Along with age, the risk of mortality decreases as shown by the mortality density graph (Fig. 4). Of all goat kids that died in the first six months of age, most of them died in the first, second and third month after birth with 43 %, 19 % and 12 % of the total kid mortality, respectively.

The results of the four mortality indicators are shown in Table 1. The mean and median neonatal mortality risk over the five-year period were 1.4 % and 0.4 %, respectively. Results of the subsequent indicators, calculated as a mortality rate, also show that the mean mortality values are higher than median mortalities indicating that the mean is influenced by a small number of herds with high mortality. For example, the average mortality in the second and third week of life is 2.4 % (median 1.0 %), 3.9 % (median 1.8 %) in the fourth to seventh week of life, and 10.0 % (median 5.2 %) in the period of eight weeks till six months of age.

3.3. Kid mortality stratified based on estimated quality of registration

The observed distribution of registered births between 2016 and 2020 differed from the expected distribution. A distribution of registered births per day of the week showed lower numbers of kids being born on

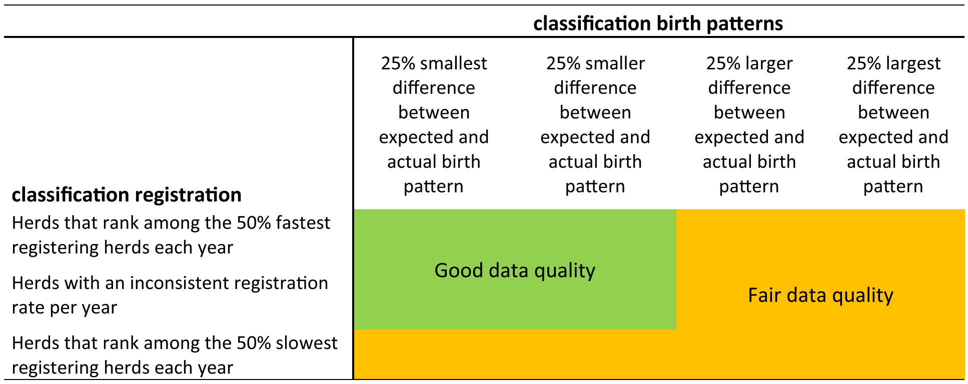

Fig. 1. Classification of goat herds based on registration of birth patters and speed of registration in Dutch dairy goat herds with registered annual kid mortality percentage (from birth to six months of age) of > 1 %.

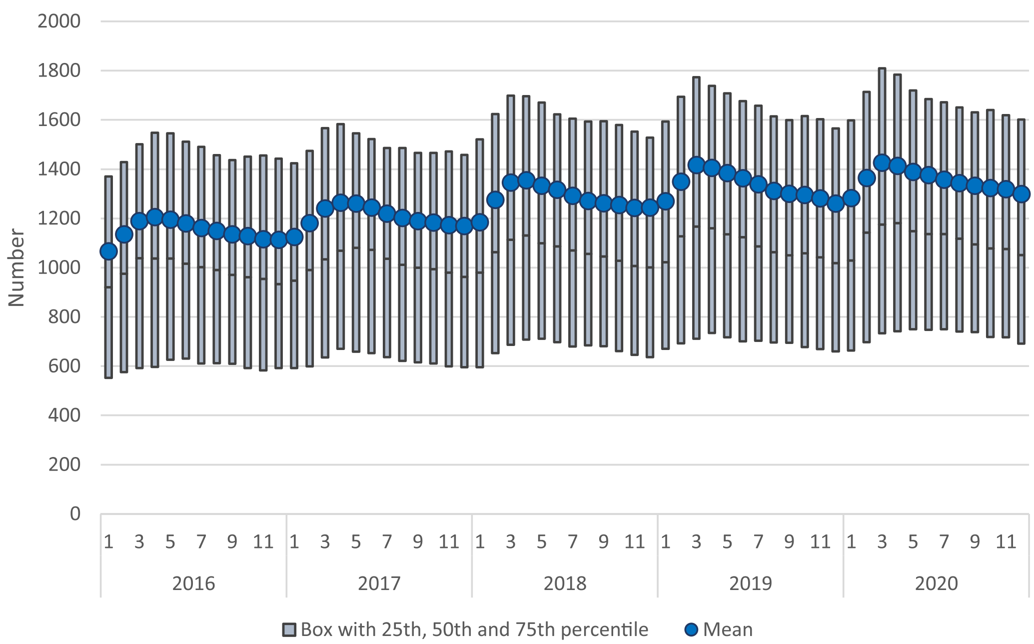

Fig. 2. Boxplot representing the 25th, 50th and 75th percentile and the mean (blue dot) total number of goats present in Dutch dairy goat herds per month between 2016 and 2020.

Saturdays and Sundays and higher numbers on Mondays and Tuesdays (Fig. 5). On the first day, each 5th day (day 5, 10, 15, 20, 25) and the last days of a month, relatively higher percentages of births were registered compared to the other days, indicating that the quality of registration is indeed a factor to consider when evaluating data quality (Fig. 6).

On average, the time between birth and registration across dairy goat herds during the study period was 43 days (median 20 days), as shown in Table 2.

Of all 395 herds investigated, 12.6 % (n = 50) were indicated to have an unreliable low mortality rate below 1 % in the first six months of age over a five-year period, and received a poor ultimate quality classification. Out of the remaining dairy goat herds, 39 % (n = 153) and 49 % (n = 192) were classified as having a good quality or fair quality classification, respectively.

These 39 % of the herds that were classified as having a good data quality were the largest herds with an average of 1209 (median 969) goats over one year of age in 2020. The 49 % of the herds with fair quality of registration kept an average of 957 adult goats (median 854), and the 13 % of the herds with a poor quality of registration kept an average of 897 (median 653) adult goats in 2020.

Mean and median kid mortality percentages in 395 dairy goat herds per key indicator are presented in Table 3 for each of the three groups of dairy goat herds. For all four mortality indicators, registered kid mortality was significantly higher in herds with a good quality of registration ($p < 0.001$) and significantly lower in herds with a poor quality ($p < 0.001$).

Mortality results of the 39 % of dairy goat herds with the most accurate data quality are presented in Fig. 7. The mean (median) mortality risk in the neonatal period between 2016 and 2020 was 2.0 % (1.1 %), and was 3.6 % (2.2 %) and 4.8 % (3.2 %) in the postnatal period and preweaning period, respectively. Mortality rates were relatively highest and showed the largest variation in the postweaning period with a mean rate of 9.8 % (7.0 %). Per year, mortality risks and rates varied.

Results of the multivariate time series negative binomial regression model showed a clear effect of the classification of registration quality registration on kid mortality; herds with the highest registration quality were found to have significantly higher mortality compared to the average (Table 4). In addition, kid mortality in 2019 and 2020 was significantly lower compared to previous years. The largest dairy goat herds recorded the lowest kid mortality. The timing of the kidding season appeared not significantly associated with kid mortality before 6 months of age.

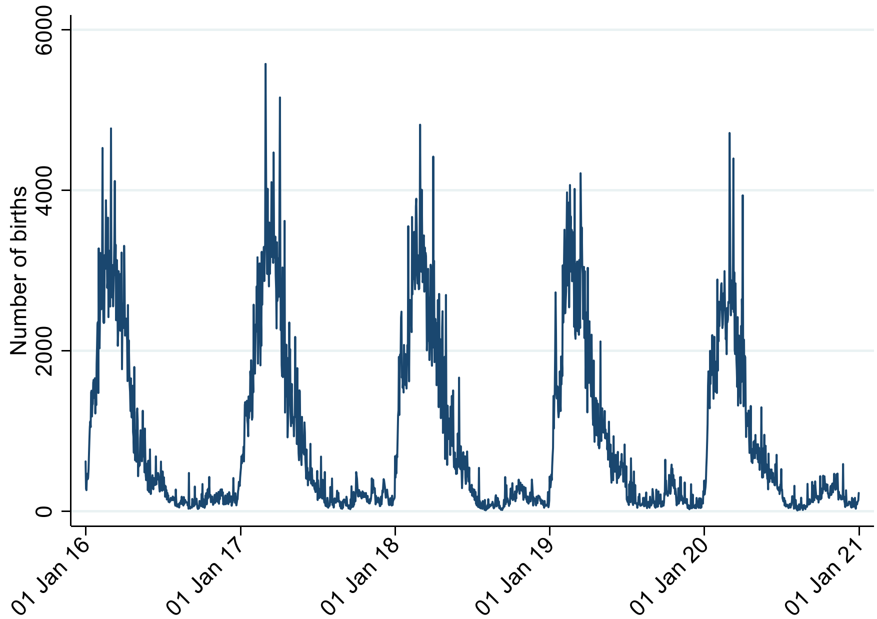

Fig. 3. Number of kid births per date between 2016 and 2020 in the Dutch dairy goat industry.

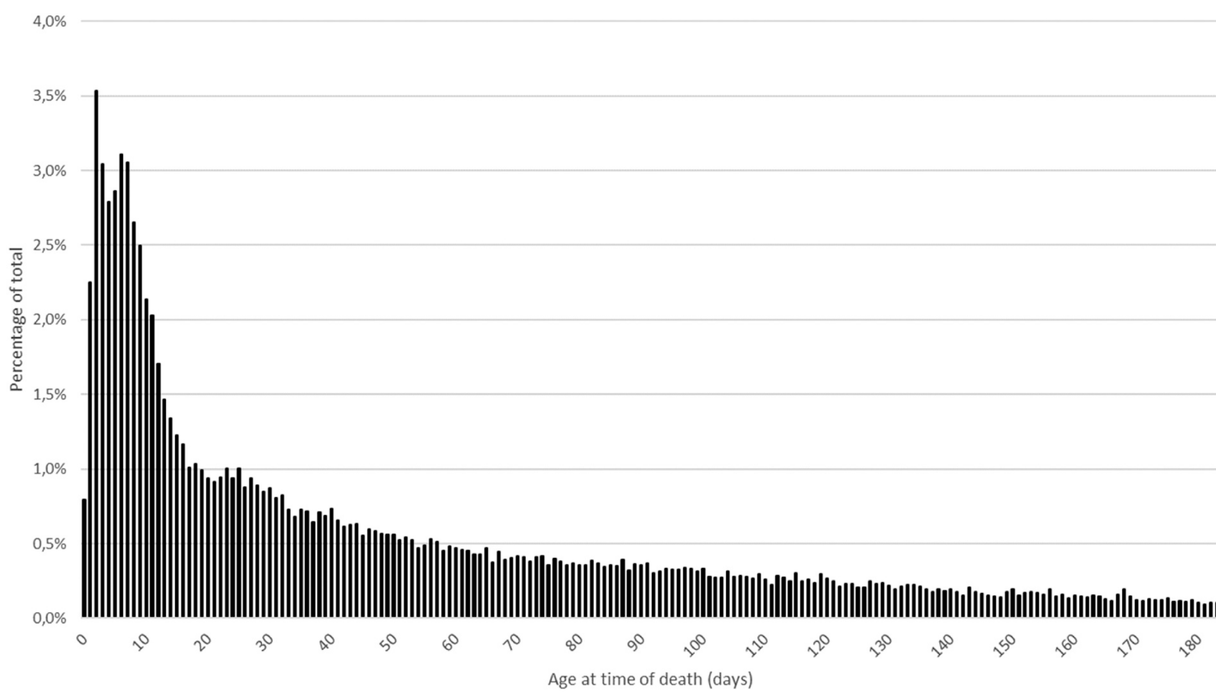

Fig. 4. Density plot of kid mortality from birth until six months of age in Dutch dairy goat herds between 2016 and 2020.

4. Discussion

Livestock farmers and veterinarians strive to improve animal health and welfare, with focus for young animals, partly to achieve production efficiency. Meanwhile, these topics are also receiving increasing attention in both social and political debate about livestock farming. Recently, supported by the government, the Dutch pig, dairy cattle and dairy goat industry started a project that aims to develop a monitoring and benchmark system focused on young animals. For the dairy cattle industry, a voluntary young stock rearing quality system has resulted in an improvement of calf rearing (Santman-Berends et al., 2018), and a clear decrease in calf mortality (Santman-Berends et al., 2021). Insight into the quality of their kid rearing is considered essential information for farmers and supports creating awareness about young stock mortality (Santman-Berends et al., 2014). This process should preferably start with the collection and analysis of reliable routine census data (Ortiz-Pelaez et al., 2008; Santman-Berends et al., 2014), tailored to each individual herd (Dwyer et al., 2016), which enables farmers to receive specific information without any extra effort. To date, other routinely collected key figures in relation to kid rearing, such as applied medication, feed intake or production performance, are not yet widely available for routine analysis. Therefore, mortality is currently the only readily available parameter as health and welfare indicator for dairy goat farmers in the Netherlands. For large dairy goat herds, no scientific research has been published on kid mortality (Ouweltjes et al., 2020), and in limited numbers of publications kid mortality percentages varied

Table 1
Mean and median percentages of the mortality indicators stratified per year in 395 Dutch dairy goat herds between 2016 and 2020.

Kid mortality indicator	Mean (median) percentage				
	2016	2017	2018	2019	2020
Neonatal mortality risk	2.4 (0.61)	1.7 (0.52)	1.4 (0.35)	0.95 (0.19)	0.87 (0.16)
Postnatal mortality rate	2.9 (1.3)	3.2 (1.3)	2.3 (0.93)	1.7 (0.62)	1.7 (0.77)
Preweaning mortality rate	3.4 (2.0)	4.6 (2.0)	4.2 (1.8)	3.0 (1.5)	4.0 (1.8)
Postweaning mortality rate	9.3 (4.5)	9.5 (5.3)	9.4 (5.9)	9.3 (5.3)	12.6 (5.2)

Table 2
Summary of mean and median intervals between birth and registration for 395 dairy goat herds per year between 2016 and 2020.

Year	Mean	p50	p25	p75
2016	75	18	9	48
2017	36	14	7	34
2018	40	25	11	48
2019	31	24	12	37
2020	32	21	11	35
Average	43	20	10	40

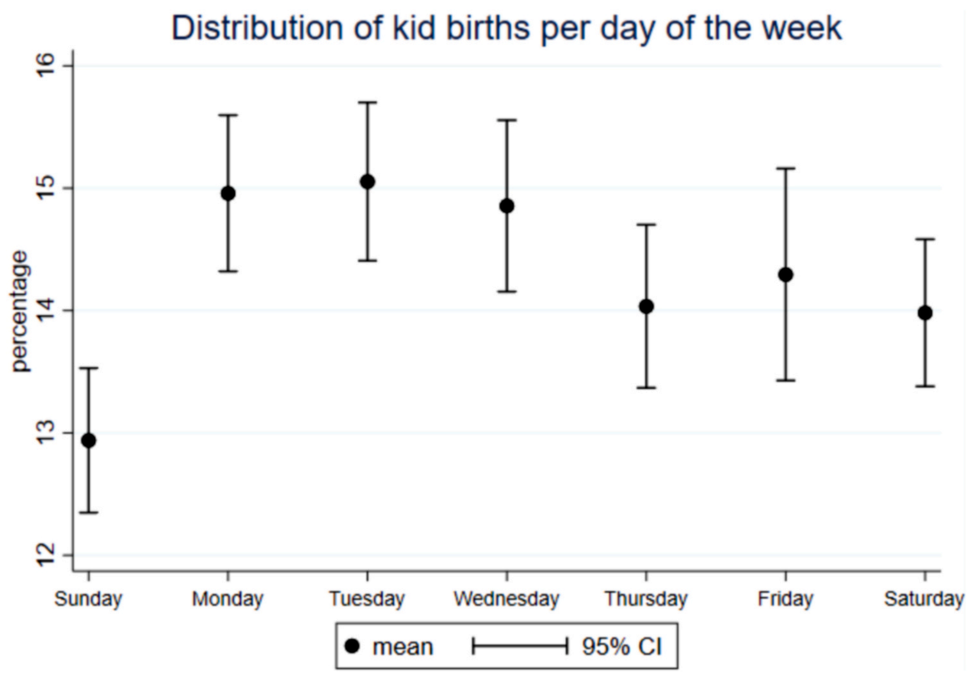

Fig. 5. Distribution of kid birth patterns per day of the week for 395 Dutch dairy goat herds between 2016 and 2020.

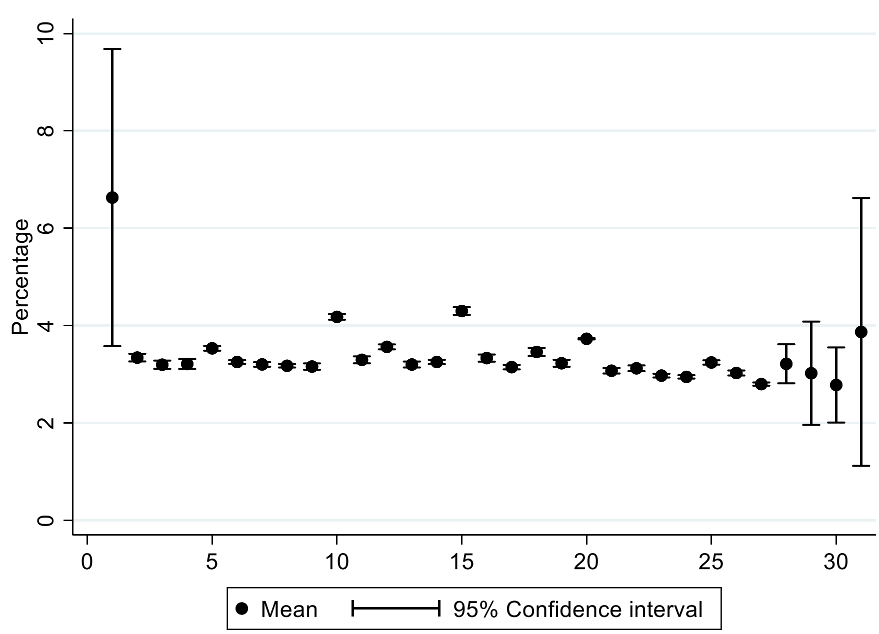

Fig. 6. Distribution of kid birth patterns per day of the month for 395 Dutch dairy goat herds between 2016 and 2020.

Table 3
Mean and median mortality percentages of the mortality indicators stratified to quality of registration in 395 Dutch dairy goat herds between 2016 and 2020.

Kid mortality indicator	Mean (median) percentage		
	Good quality (39 % of herds)	Fair quality (49 % of herds)	Poor quality (13 % of herds)
Neonatal mortality risk	2.0 (1.1)	1.3 (0.1)	0.03 (0)
Postnatal mortality rate	3.6 (2.2)	1.8 (0.6)	0.1 (0)
Preweaning mortality rate	4.8 (3.2)	3.1 (1.5)	0.7 (0)
Postweaning mortality rate	9.8 (7.0)	9.3 (4.9)	2.3 (0)

between 7 % and 32 %. Nevertheless, these studies are difficult to compare given the differences in herd size and additional circumstances (Ouweltjes et al., 2020).

According to the recorded kid mortality between 2016 and 2020, the first month of life tends to be most critical as 43 % of the reported kids died in the first four weeks after birth. However, to indicate more specifically at which points kid rearing results are convenient or need improvement, we defined four key indicators for the first six months of rearing. During the neonatal period, the risk of mortality was highest in most herds, which is in agreement with other studies that focussed on kid mortality (Robertson et al., 2020; Todd et al., 2019), and has also been described for other animal species such as dairy cattle and sheep (Binns et al., 2002; Nash et al., 1996; Santman-Berends et al., 2019). Compared to the later rearing periods, high neonatal mortality might require an assessment of gravid doe management, in addition to an evaluation of sanitation and implementation of preventive health care such as increased hygiene measures, umbilical cord disinfection and colostrum intake (Dwyer et al., 2016). In the postnatal period, a considerably lower mortality rate is expected, which was also shown in our results. Although Todd et al. (2019) found gastrointestinal disorders, pneumonia or disbudding-related injuries as major causes of death for dairy goat kids in New Zealand, in the Netherlands, infectious diseases such as respiratory problems, joint inflammations or gastrointestinal disorders often occur during this period (Royal GD, 2022). The preweaning period comprises the period around weaning, a physiologically stressful process that is regularly associated with health problems (Aufy et al., 2016; Magistrelli et al., 2007). An optimal weaning strategy is considered essential for intestinal health and efficient absorption of nutrients from solid food, hence kid development. In the Dutch dairy goat system, kids are generally weaned in the sixth or seventh week of life. During the final postweaning period, kids continue their development until mating around the seventh month of life. Although management during this period generally remains largely unchanged, health issues that have occurred in previous periods will manifest in terms of chronic disease or retarded development.

In addition to defining rearing periods, the way mortality is presented should also be carefully considered. In this study, with the exception of the first week of life, a mortality rate was calculated. A mortality rate is considered scientifically sound and, unlike a mortality risk, takes into account the time kids are actually in the herd and at risk. However, a comparable study with dairy calves indicated that a mortality rate is more complex to explain to livestock producers compared to a mortality risk (Santman-Berends et al., 2019). According to national regulations, kids are not allowed to be transported within the first week of life, causing a minimal difference between the mortality rate and the mortality risk for this period. It is therefore justified to use a mortality risk as parameter for the neonatal period. Many farmers choose not to raise buck kids themselves, but either sell them at young age for slaughter or less common to a fattening location, and some farmers feature an external rearing location for doe kids. Whereas a mortality risk will cause an underestimation of mortality for the periods in which kids can be freely transported off and on farm, a mortality rate is considered the parameter of choice.

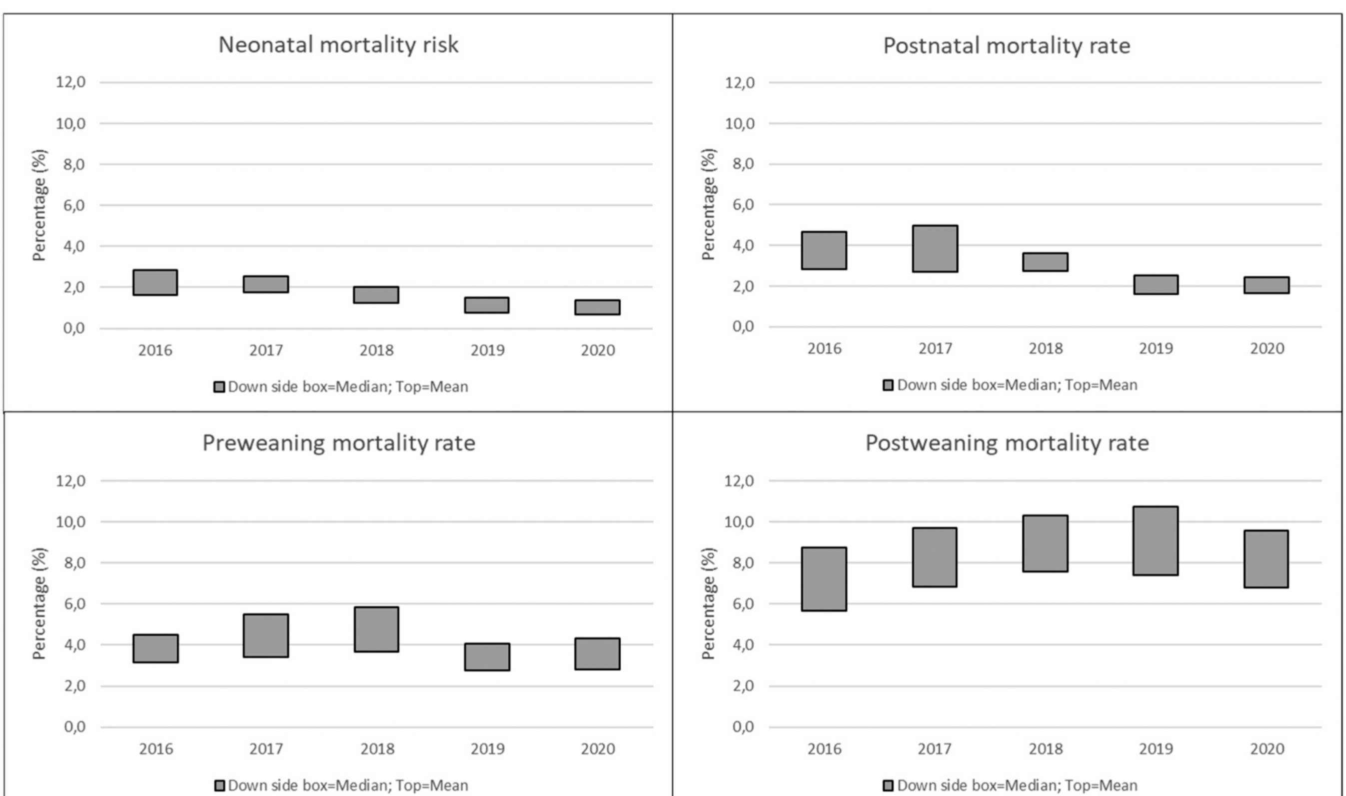

Fig. 7. Results of the four kid mortality indicators per year in the group of 39 % dairy goat herds with an indication of high data quality.

Table 4
Results of the multivariable time series negative binomial regression model of kid mortality before six months of age on dairy goat farms between 2016 and 2020.

Parameter	Incidence rate ratio	95 % Confidence interval	P-value
Classification registration quality			
Total average	Reference		
Good	**2.17**	**1.98–2.37**	**<0.001**
Fair	**1.42**	**1.30–1.55**	**<0.001**
Poor	**0.32**	**0.28–0.37**	**<0.001**
Year			
2016	Reference		
2017	1.01	0.93–1.10	0.82
2018	0.97	0.89–1.05	0.45
2019	**0.82**	**0.75–0.90**	**<0.001**
2020	**0.91**	**0.83–1.00**	**0.04**
Herd size			
Total average	Reference		
25 % smallest herds	1.05	0.97–1.14	0.24
25 % smaller herds	1.06	0.99–1.14	0.08
25 % larger herds	1.00	0.93–1.06	0.91
25 % largest herds	**0.90**	**0.83–0.97**	**0.005**
Peak month of births			
Total average	Reference		
January-December	NS	NS	NS

In their preliminary analysis of kid mortality in professional dairy goat herds in the Netherlands in the first six months of age, that was conducted in 2017 (Santman-Berends and Vellema, 2017), mortality percentages in dairy goat herds varied from 0 % to 38.3 %, with a mean and median percentage of 6.7 % and 4.4 %, respectively. The authors indicated that current I&R regulations could lead to an underestimation of mortality, and the resulting hypothesis that farmers which register kids immediately after birth have a higher registered mortality compared to farmers that postpone registration. This hypothesis was investigated in the current study and was supported by our results that show a significant association between quality of registration and registered kid mortality in a multivariable regression poisson model together with the confounding factors herd size, peek lambing month, and trend in time. This substantiates the importance to differentiate groups of dairy goat herds based on quality and completeness of registration when calculating mortality indicators.

Three parameters were used to categorise herds regarding the accuracy and completeness of animal registration based on data entered by farmers in I&R. All parameters separately proved to be successful for the indication of a registration bias. Analysis of birth patterns indicated that some farmers might maintain fixed days of the week or month for processing birth registration as fewer births were registered on Sundays compared to remaining days, as well as on the first and last days of the month. A declining trend in time was noticed in the average time between birth and the moment of registration, especially among farmers who generally register their animals late (Table 2). Taking into consideration the regulatory change from November 2020, stating that not only live-born but also stillborn kids have to be registered in I&R within seven days of birth, stating gender (Regeling van de Minister van Landbouw, Natuur en Voedselkwaliteit van 10 september 2020, nr. WJZ/ 20216849, 2020), farmers may have become more aware of the timely registration of kids. A minimum mortality percentage of >1 % was considered a realistic mortality. Nevertheless, in 12.5 % of the herds, a mortality percentage equal to or lower than 1 % was registered in all years between 2016 and 2020. These herds, with an expected poor quality of registration, had on average the smallest herd size in 2020, whereas herds with a good registration quality had the largest herd size. This difference in registration might be explained by the fact that large producers more often implement standardized activities and procedures because they are more dependent on hired personnel.

After classification, all four mortality indicators appeared strongly associated with data quality. This can partly be explained by the mortality definitions used, since herds with an improbably low mortality were automatically classified as having poor data quality. Nevertheless, significant differences were also observed between good and fair registration quality. It is expected that differences in registration quality between dairy goat herds will become smaller from November 1st 2020, given the changed regulations that went into force on that date. To analyse whether these changes in regulation affect the registration quality and thus kid mortality data, it is recommended to repeat the current analyses on data from 2021 and later years. Based on the results obtained, it can be decided whether it remains necessary to categorise dairy goat herds into groups based on registration quality, to prevent misclassification of herds with a complete registration as having high kid mortality and herds with incomplete registration as having lower kid mortality. In case no further categorisation should be made, account must be taken that for optimal usability of a tool that provides insight in kid mortality, the quality of registration must meet certain requirements.

Within this study, mortality parameters could not be analysed per sex as gender data were not yet consequently available. With the enforcement of the above mentioned new regulations, these data have to be registered by dairy goat farmers. Because management regarding care for buck kids sometimes differs from that of doe kids, this might provide valuable additional information regarding farm management (Meijer et al., 2021).

To be able to further develop the mortality indicators as presented into applicable key management indicators that enable producers to optimise kid rearing, there is a need for a benchmark in addition to farm specific results. A sociological study of Santman-Berends et al. (2014) showed that farmers often were not aware of the average calf mortality in Dutch dairy cattle herds and were, therefore, unable to assess their own mortality rates. However, the current study shows that it is advisable to determine benchmark values per quality category to enable a fair cross-herd comparison, or to base a benchmark solely on mortality results of herds with an indication for good or even excellent quality of registration since results of herds with a fair and poor quality of registration indicate an underestimation of mortality.

This study shows that it is possible to develop reliable indicators for kid mortality in dairy goat herds based on census data. However, it also shows that different factors need to be considered in defining reliable parameters. Mortality, especially in young animals, is a sensitive concept, for both professionals and the general public. It is therefore important that mortality figures are always communicated in a correct context and perspective.

5. Conclusion

Young stock rearing is considered important by dairy goat farmers as rearing practices largely affect kid development and therefore future success. In Dutch dairy goat farming, kidding seasons are generally limited to a short period annually, during which large numbers of kids are born. High workload, limited housing capacity and increasing disease pressure are common complicating elements that can cause kid rearing to be challenging. To be able to evaluate rearing results and to identify potential risk periods, data collection regarding kid health and development is essential. However, on many farms, data collection is still rudimentary and the current lack of references and practical tools to raise goat kids efficiently complicate the monitoring of rearing results and effective improvement. Mortality is considered a significant indicator of animal welfare, and the neonatal, postnatal, preweaning and postweaning mortality risk and rate are reliable indicators for kid mortality in dairy goat herds, provided that the quality of registration meets the legal requirements.

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Declaration of Competing Interest

The authors declare no conflict of interest.

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