

Item 1: Title

Investigating dairy goat kid mortality and associated risk factors: a scoping review

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Author contributions:

JK drafted the review protocol with input from CW, CB, PM, JJ and JW.

Item 2: Structured Summary/Abstract

Background: The dairy goat industry in Ontario has undergone tremendous growth over the last 15 years in response to the increased demand for goat milk-based products. It is well established that the overall profitability of dairy goat operations is heavily influenced by kid survival. In Ontario, kid mortality on dairy goat farms has been estimated to be 20% from birth to weaning which greatly exceeds the average dairy calf mortality rate during the same period. Overall, there is a lack of published literature regarding rates and causes of kid mortality. There is a need for increased research into the levels of dairy goat kid mortality and exploration of mortality risk factors in different production systems.

Objectives: The goal of this review is to identify and characterize the available literature describing or examining dairy kid mortality from birth to 4 months of age. This scoping review will identify the reported levels of mortality, categorize the mortality risk factors (if examined), and identify knowledge gaps in the literature.

Design:

Only primary research will be eligible for inclusion. The study population will be restricted to goat kids of any dairy breed from birth to four months of age, in any type of dairy production (e.g. research and commercial herds, low or high level of production, pastured or intensively reared, handmilked or parlour, etc.). Mortality for the study population must be reported, but there will be no restriction on the time period it was examined over. The study selection and inclusion process will be reported using a Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) flowchart (Moher *et al.* 2009). Frequency tables will be constructed for descriptive summaries of the included studies, including definition of mortality, risk period, and overall study observations, characteristics, and populations. The results of studies included will be reported in summary tables and figures. This review will be reported follow the framework outlined by the PRISMA-extension for Scoping Reviews (PRISMA-ScR) (Tricco *et al.* 2018).

INTRODUCTION**Item 3: Rationale**

The dairy goat industry in Ontario has undergone tremendous growth over the last 15 years in response to the increased demand for goat milk-based products. Corporate investment in this market provided stability in price and further opportunities to grow. Despite promising growth, over the last year there has been a surplus of goat milk available on the market, resulting in a decrease in the milk price. Thus, the need for research into increasing production efficiency while

promoting animal welfare is paramount to maintaining the dairy goat industry while preserving its ability to rebound in the future.

Profitability of dairy goat operations is heavily influenced by kid survival. The post-natal period in the dairy goat industry is difficult to manage due to the large number of kids born in a short period of time, which makes the animals susceptible to failure of passive transfer, and thus at a subsequently increased risk of morbidity and mortality. A recent survey undertaken at the University of Guelph indicated that producer-reported mortality in the first 28 days of age is approximately 20% (Oudshoorn *et al.* 2016). This greatly exceeds the average calf mortality rate in dairy cattle (8 to 11%) (Murray 2010). Furthermore, this value may be underestimated as the survey was administered via mail and internet, with a low response rate (17.1%). It is important to consider that producers with high mortality may have been less likely to respond to the survey resulting in an underestimate of the actual level of mortality present on-farm. In addition, results from previous studies of the dairy goat (and dairy cattle) industry conducted on-farm, have shown that few producers have strong record-keeping practices (Bauman 2013; Winder *et al.* 2018), therefore it is unlikely that all producers accurately quantify mortality. Overall, when compared to other production animal systems such as dairy cattle, there is a lack of published literature regarding rates and causes of kid mortality. Although also ruminants, goats vary significantly from dairy cattle with respect to basic physiology and in their on-farm management. There is a need for increased research into the levels of goat kid mortality and exploration of mortality risk factors in different production systems.

A synthesis of research describing dairy kid mortality and examination of associated risk factors could help to identify and describe the existing literature and provide directions for future research. This review will be reported following the framework outlined by the Preferred Reporting Items for Systematic reviews and Meta-Analyses-extension for Scoping Reviews (PRISMA-ScR) (Tricco *et al.* 2018).

Item 4: Objectives

The goal of this review is to identify and characterize the available literature describing or examining dairy kid mortality from birth to 4 months of age. This scoping review will describe and categorize the mortality risk factors (if examined). Additionally, this review will provide an organized summary of studies available while identifying knowledge gaps in the literature.

METHODS

Item 5: Protocol and Registration

This protocol will be archived in the Atrium at the University of Guelph (<https://atrium.lib.uoguelph.ca/xmlui/handle/10214/10046>) and will be available online with Systematic Reviews for Animals and Food (SYREAF) (<http://www.syreaf.org/>).

Item 6: Eligibility Criteria

Only primary research will be eligible for inclusion with any type of study being included (descriptive or observational). The study population will be restricted to goat kids of any dairy breed from birth (born alive) to four months of age, in any type of dairy production (e.g. research and commercial herds, low or high level of production, pastured or intensively reared, handmilked or parlour, etc.) or any herd size. Any publication that includes data on stillbirths or late-term abortions will be included only if the study also describes mortality in goat kids after birth; if the study addresses solely stillbirths or late-term abortions the study will be excluded. Mortality for

the study population must be reported, but there will be no restriction on the time period it was examined over. All publications to be included will be restricted to those available in English language. No geographical restrictions will be placed on eligibility. The only date restriction imposed will be that of the databases used.

Item 7: Information Sources

A comprehensive literature search will be conducted through the McLaughlin Library, University of Guelph in the following electronic databases: CAB Direct (via CABI), Medline, ProQuest (Agricultural & Environmental Science Database, Biological Science Database, Dissertations & Theses @ University of Guelph) Web of Science, AGRIS (united nations, food and agriculture organization).

The search strategy implemented for this review was developed using key concept terms and words, singly and in combination, for preliminary broad searches. We will utilize the results from these initial searches to further refine and format each search string for each search platform. Search strings terms will be combined using the Boolean operator ‘OR’ and we will group key words according to population terms and outcome terms. Population terms and outcome terms will be connected by the Boolean operator ‘AND’ when implemented in a search string.

Item 8: Search

Table 1. Results of a search to identify studies reporting or examining mortality in dairy goat kids, conducted in CAB Direct (via CABI) on February 25, 2019.

#	Search terms	Results
1	Kid or goat or caprine	132, 620
2	dairy or neonatal or perinatal or neo-natal or peri-natal or pre-weaned or preweaned or prewean or pre-wean or weaned or wean or milk-fed or newborn	546, 835
3	mortality or death or loss or losses or carcasses or carcass or postmortems or post-mortems or died or die or survivability or survival	1, 352, 811
4	Stillbirth or “late term abortions” or still-birth	7567
5	3 or 4	1,354,620
6	1 AND (3 or 4)	16,666
7	(1 AND 2) AND (3 or 4)	2682

Item 9: Selection of sources of evidence

Two levels of eligibility screening will be utilized to select studies relevant for this review. Relevance screening will be completed by two independently operating reviewers.

Level 1

For the first level of screening, the title, abstract and index terms will be reviewed using the following list of questions that may be answered as either “yes”, “no”, or “unclear”. Disagreement on answers to the list of level 1 screening questions will be resolved by consensus, however if not reached the article will be labelled as “unclear” and undergo level 2 screening. Pre-testing will be done on the first 250 studies for all reviewers to ensure a similar understanding of the questions.

- 1) Is the title/abstract available in English? “yes” (neutral), “unclear” (neutral), “no” (exclude)
- 2) Is the citation a primary research study? “yes” (neutral), “unclear” (neutral), “no” (exclude)
- 3) Does the title/abstract investigate or describe mortality in dairy goat kids? “yes” (include), “unclear” (include), “no” (exclude)

Level 2

A second level of screening will be conducted on available full text publications. The second level of screening will use the following list of questions that may only be answered by “yes” (neutral) or “no.” Any disagreement on answers to the list of level 2 screening questions will be resolved by consensus, with intervention by a third reviewer if necessary. Pre-testing will be done on the first 20 studies for all reviewers to ensure a similar understanding of the questions. Exclusions at level 2 screening will be documented.

- 1) Does the full text article describe a primary research study? “yes” (neutral), “no” (exclude)
- 2) Is the full text article available in English? “yes” (neutral), “no” (exclude)
- 3) Does the full text article investigate or describe mortality in dairy goat kids? “yes” (include), “no” (exclude)
- 4) Does the full text investigate or describe stillbirths in dairy goat populations? “yes” (neutral), “no” (neutral)

Item 10: Data Charting Process

The study selection and inclusion process will be reported following the PRISMA flowchart (Moher *et al.* 2009). Frequency tables will be constructed for descriptive summaries of the included studies in this review including study characteristics and target populations. The results of studies included will be reported in summary tables and figures.

Item 11: Data items

Data Management

Search results will be uploaded into EndNote (Clairvate Analytics, Philadelphia, USA) reference management software and duplicates will be removed. The included references will be imported into DistillerSR (Evidence Partners Inc., Ottawa, Canada) where additional duplicates will be removed, and studies will be screened and data extraction completed.

Data Extraction

Full text publications will be acquired and uploaded into the commercial review management program DistillerSR. Data extraction will be done independently by two reviewers with conflicts resolved by consensus, and mediation by a third reviewer if necessary (CB or JW). The data extraction form will be piloted on 10 studies to ensure clarity of the form and a similar understanding of the form by all reviewers. Data extraction will be completed using structured pre-tested forms created in DistillerSR that will include:

- 1) General study characteristics: publication year, year of study conduct, and region where study conducted
- 2) Study approach
 - a. Descriptive (case reports, case series report, descriptive studies)
 - b. Analytical
 - i. Observational study (hypothesis testing)
 - ii. Intervention study
- 3) Study objectives and hypotheses (if applicable)
- 4) Study population: farm type/herd type, breed, age, sex
- 5) Sample size
- 6) Mortality
 - a. Definition/time at risk
 - b. Dichotomous data – number dead, number at risk
 - c. Continuous data - central tendency metric, spread measure
- 7) Risk factors for mortality examined in the study

Item 12: Synthesis of Results:

Tables will be used to record study statistics that will include descriptive analysis of study characteristics (date of publication, geographical region), target population, sample size and the study approach. We will also include the definition and measures of mortality used in each study and the general findings or conclusions drawn. A combination of summary figures and tables will be used as needed to appropriately report study results. A map will be used to demonstrate the scope of geographical areas where eligible studies were conducted. A histogram will be used to demonstrate the total number of eligible studies published by year.

RESULTS

Item 17: Selection of source of evidence

A flow chart will be used to demonstrate the study inclusion process. The total number of screened studies, including those assessed for eligibility and included in the review will be given. Furthermore, if any study was excluded during the selection process the reason will be documented. The full electronic search strategy for at least one database will be provided via a summary table such that the search could be replicated.

Item 18: Characteristics of sources of evidence

Tables will be used to record study statistics that will include study characteristics (date of publication, date of conduct, geographical region), target population, sample size, and study design.

Item 20: Results of individual sources of evidence:

The overall goals from this review are to identify eligible research papers that report the level of mortality reported in dairy goat kids from birth to four months of age, and if applicable, any associated risk factors. We will report the definition and measures of mortality, as well as the study methodology used to determine the level of mortality in the identified population. We will list the risk factors that have been examined for kid mortality.

DISCUSSION

Item 24: Summary of evidence

By conducting this scoping review, we will be able to present a summary of the available primary research investigating the level of mortality in dairy goat kids from birth to four months of age and the risk factors associated with an increased risk for mortality globally. The results we obtain from this review will help identify knowledge gaps in the current body of literature therefore directing future research in a direction that will benefit and support the growth of the dairy goat industry.

Item 25: Limitations

As a scoping review is very broad, there was some difficulty in establishing appropriate boundaries with respect to literature inclusion and exclusion. Currently, the available body of literature is small and thus restricting eligible studies to those only available in English might eliminate some important data. Furthermore, this review will only list the information from our search and will not attempt to synthesize the data nor appraise the quality of the research conducted, therefore limiting the utility of our findings to identifying knowledge gaps and inform future research.

Item 26: Conclusions

This scoping review will provide an overall summary of primary research being conducted on a global scale that addresses dairy goat kid mortality and any associated risk factors. The results obtained can be used to better understand the current state of knowledge, identify any information gaps, and aid to inform future scientific research studies. We hope that by providing a summary of the data available we will be able to identify any important knowledge gaps in the literature. In order to reduce the death of goat kids on-farm, producers need to be able to understand the diseases and risk factors most likely to be responsible, and target these with preventive measures such as vaccination and reducing over-stocking. By conducting this study, we are providing support for industry stakeholders, veterinarians and producers struggling with high levels of mortality on-farm while improving the welfare of herds in various countries.

Item 27: Funding

This scoping review is part of a larger project consisting of a cross-sectional study currently being conducted in Ontario to investigate the level of kid mortality on dairy goat farms. The funding for this study, and thus this review, was provided by the Ontario Veterinary College at the University of Guelph, the Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA), the Natural Sciences and Engineering Research Council (NSERC), Ontario Goat, Gaylea, Saputo, the Ontario Dairy Goat Co-operative, and the American Dairy Goat Association.

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