Animal Reproduction Science xxx (xxxx) xxx–xxx

Contents lists available at ScienceDirect

Animal Reproduction Science

journal homepage: www.elsevier.com/locate/anireprosci

Nulliparous and primiparous cows produce less fertile female offspring with lesser concentration of anti-Müllerian hormone (AMH) as compared with multiparous cows

V. Akbarinejad*, F. Gharagozlou, M. Vojgani, M.M. Bagheri Amirabadi

Department of Theriogenology, Faculty of Veterinary Medicine, University of Tehran, Tehran, Iran

ARTICLE INFO

Keywords:
Bovine
Maternal parity
Reproductive performance
AMH

ABSTRACT

Nutritional partitioning to fetal development differ among nulliparous, primiparous and multiparous cows, leading to birth of smaller calves to nulliparous and primiparous than multiparous dams. The prenatal nutritional state could influence ovarian reserve and fertility in the adult offspring. The effect of maternal parity on ovarian reserve and reproduction of female offspring, however, has not been investigated in cattle. Accordingly, a retrospective research was conducted to study reproductive variables in nulliparous- (n = 310), primiparous- (n = 236) and multiparous-born (n = 323) female offspring during the first four lactation periods in dairy cows. Additionally, anti-Müllerian hormone (AMH), as a reliable marker of ovarian reserve, was measured in a subset of nulliparous- (n = 51), primiparous- (n = 51) and multiparous-born (n = 49) female offspring. Birth weight in multiparous-born calves was greater than that in nulliparous- and primiparous-born calves ($P <$ 0.01). Days to first service was shorter in multiparous-born female offspring as compared with nulliparous- and primiparous-born female offspring ($P <$ 0.05). First service conception rate, proportion of repeated breeders, service per conception and calving to conception interval were greater in multiparous-born than nulliparous-born cows ($P <$ 0.05). Cumulative culling rate was greater in primiparous-born cows than nulliparous- and multiparous-born cows ($P <$ 0.05). The AMH concentration was greater in multiparous-born than nulliparous- and primiparous-born cows ($P <$ 0.05). In conclusion, the present study revealed that in comparison with multiparous cows, nulliparous and primiparous cows, particularly nulliparous cows, produce female offspring with lesser reproductive performance and smaller size of ovarian reserves.

1. Introduction

Development of ovaries and primordial follicles occurs during fetal period in several mammalian species including ruminants and humans, and in turn, each individual female is born with fixed number of primordial follicles, which is considered as the ovarian reserve (Yang and Fortune, 2008; Ireland et al., 2011; Findlay et al., 2015). Given that there is no development of primordial follicles after birth, the size of ovarian reserve depletes as continuous reproductive cycles occur as a female ages until a limited number of primordial follicles remains, at which time ovarian activity becomes irregular causing ovarian failure (Ireland et al., 2011; Richardson et al., 2014; Findlay et al., 2015). Furthermore, size of ovarian reserve is associated with oocyte quality (Ireland et al., 2009), embryonic competence (Tessaro et al., 2011) and fertility (Mossa et al., 2012; Ribeiro et al., 2014; Jimenez-Krassel et al.,

* Corresponding author at: P.O. Box: 14155-6453, Tehran, Iran.
E-mail address: v_akbarinejad@ut.ac.ir (V. Akbarinejad).

https://doi.org/10.1016/j.anireprosci.2018.08.032
Received 1 June 2018; Received in revised form 10 August 2018; Accepted 24 August 2018

2015). Hence, not only are cows with smaller ovarian reserves expected to have a shorter productive life (Jimenez-Krassel et al., 2015), these cows also have lesser pregnancy rates (Mossa et al., 2012; Ribeiro et al., 2014), more services per conception (Mossa et al., 2012) and longer calving to conception intervals (Mossa et al., 2012).

Genetics and the environment are the two major factors affecting size of ovarian reserves (Mossa et al., 2013; Richardson et al., 2014; Walsh et al., 2014). Prenatal or intrauterine nutrition is one of the important environmental factors which could influence the development of ovaries and primordial follicles (Richardson et al., 2014). In this regard, reduced markers of ovarian reserve have been observed in calves following prenatal dietary restriction (Mossa et al., 2013). Furthermore, the negative effect of maternal heat stress during pregnancy on the ovarian reserves and fertility in female offspring has been attributed to intrauterine undernutrition, either by reducing the maternal appetite or secondarily via causing placental dysfunction (Akbarinejad et al., 2017).

In the dairy industry, heifers are first inseminated at the age of 13 to 15 months, when they are at 55% to 65% of their mature weight (Larson and Randle, 2007; Swali and Wathes, 2007; Wathes et al., 2014). Subsequently, these heifers calve for the first time when they are approximately 2 years old, when they have reached to 85% of their mature weight (Larson and Randle, 2007; Wathes et al., 2014). As a result, nulliparous and primiparous cows differ from multiparous ones in terms of nutritional partitioning because nulliparous and primiparous cows, particularly nulliparous cows, should allocate a portion of their nutritional intake to their own growth and development (Larson and Randle, 2007; Wathes et al., 2014). It could be hypothesized, therefore, that offspring of nulliparous and primiparous cows have a lesser portion of their nutritional intake partitioned for fetal development as compared with offspring of multiparous cows. This hypothesis is supported by the evidence that calves with nulliparous dams are lighter in body weight than those born to multiparous cows (Small et al., 2000; Atashi et al., 2012). Whether dam parity could affect ovarian reserve or fertility in offspring has not been investigated, however.

A retrospective study, therefore, was performed to evaluate whether maternal parity could influence birth weight, ovarian reserve and fertility of offspring in dairy cows. Anti-Müllerian hormone (AMH) was used for the assessment of ovarian reserves. Serum AMH concentration is associated with the size of ovarian reserves (La Marca and Volpe, 2006; Ireland et al., 2008; Mossa et al., 2017) and has minimal day-to-day variation within individuals over the course of reproductive cycles in cattle (La Marca et al., 2006; Rico et al., 2009; Ireland et al., 2011).

2. Materials and methods

2.1. Animals

Animal Ethics Committee at University of Tehran approved the present study in terms of animal welfare and ethics.

The present study was conducted at a commercial Holstein dairy herd, in which voluntary waiting period before the first postpartum insemination was 42 days and cows were inseminated 12 h after standing estrus was detected. Estrus was detected thrice daily by visual observation for at least 30 min each time. All artificial inseminations were conducted by the same technician and pregnancy diagnosis was implemented 40 to 45 days after AI by trans-rectal palpation. The research was composed of two separate studies. In Study 1, data of reproductive parameters of offspring associated with mothers of different parities were collected so as to evaluate the impact of maternal parity on fertility of offspring. In Study 2, blood samples were collected from offspring of mothers with different parities to investigate the influence of maternal parity on AMH concentration as a biomarker of ovarian reserves.

2.2. Study 1

2.2.1. Data

Data associated with female offspring conceived from 2003 to 2007 were collected from the herd database. To investigate the effect of maternal parity, female offspring were classified in three categories: 1) nulliparous-born cows, which were born to first parity dams that had no previous parturitions; 2) primiparous-born cows, which were born to second parity dams that had one previous parturition; and 3) multiparous-born cows, which had dams that had three or more previous parities. Because of the intent to investigate fertility variables in the same population of each category over the first, second, third and fourth lactation periods, the data of cows that were missing were excluded from the analysis. In total, data consisted of 869 cows, of which 310, 236 and 323 were nulliparous-, primiparous- and multiparous-born, respectively. Additionally, data pertaining to birth weight of the respective offspring were assessed. Birth weight was measured immediately after parturition and prior to feeding colostrum to calves.

2.2.2. Reproductive variables

Days to first service (DFS) was defined as the interval from parturition to first insemination. First service conception rate (FSCR) was defined as the proportion of cows diagnosed pregnant following the first insemination postpartum. Cows that failed to conceive after three services were considered as repeat breeder (RB) cows. Services per conception (SPC) were defined as the number of services that occurred before conception in cows. Calving to conception (CCI) interval was defined as the number of days from parturition to conception. Days to first service, FSCR, RB, SPC and CCI were calculated using the data of cows diagnosed pregnant and the data of cows that failed to conceive were not considered for calculations of values for the respective variables. Culling rate (CR) was defined as the proportion of cows that were removed from the herd before the subsequent lactation period could be initiated.