DOI: 10.22059/IJVM.2020.309538.1005125 Iranian Journal of Veterinary Medicine Original Article

Online ISSN: 2252-0554

Greater Reproductive Performance in Holstein Dairy Cows with Moderate Length of Anogenital Distance at First Service Postpartum

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Abstract

BACKGROUND: Previous studies have indicated negative association of anogenital distance (AGD) with fertility in dairy cows; however, the mechanism of inverse relationship is not completely understood. In this regard, postpartum uterine infections and their corresponding risk factors could diminish fertility of cows, yet there has been no research exploring the relationship between AGD and postpartum disorders.

OBJECTIVES: The aim of this study was to investigate the relationship between AGD and postpartum reproductive performance in dairy cows.

METHODS: AGD of Holstein dairy cows of a commercial dairy herd (n = 290) was measured at the first postpartum examination (days 28 to 32 postpartum) in millimeter. Cows were classified into three categories based on AGD length, including short anogenital distance (20% of cows with lowest values), intermediate anogenital distance (60% of cows with moderate values) and long AGD (20% of cows with highest values). Additionally, data of postpartum reproductive variables were retrieved form herd database. Dara were analysed using SAS software version 9.4.

RESULTS: Rate of dystocia, twinning, retention of fetal membranes, puerperal metritis and clinical endometritis, calf birth weight and days to first service did not differ among the various AGD categories ($P > 0.05$). However, proportion of male offspring was lower in short AGD cows than intermediate and long AGD cows ($P < 0.05$). Furthermore, first service conception rate was greater in intermediate anogenital distance group than short and long anogenital distance groups ($P < 0.05$).

CONCLUSIONS: In conclusion, the present study showed suboptimal first postpartum conception rate in cows with minimal and maximal length of anogenital distance and indicated that this inferior fertility was not mediated through alteration in rate of postpartum reproductive disorders.

KEYWORDS: Anogenital distance; Dairy cows; Dystocia; Fertility; Uterine infections

Introduction

Anogenital distance (AGD), which is defined as the distance between anus and clitoris in female individuals, is an anthropometric index reflecting fetal exposure to androgens (Gore et al., 2015; Thankamony et al., 2016; 2016; Gobikrushanth et al., 2017; Akbarinejad et al., 2019). Hereby, AGD is suggested as an indicator for assessment of the impact of endocrine disruptor chemicals on ontogeny of reproductive organs in male and female offspring (Gore et al., 2015; Thankamony et al., 2016; Gobikrushanth et al., 2017; Akbarinejad et al., 2019). More recently, Gobikrushanth et al. 2017 characterized AGD in dairy cows and found that length of AGD was adversely associated with first service conception rate and likelihood of pregnancy in dairy cows (Gobikrushanth et al., 2017). Furthermore, another study substantiated the inverse association of AGD length with fertility in dairy cows and reported delayed first postpartum insemination, diminished first service conception rate, escalated proportion of repeat breeders and prolonged calving to conception interval in dairy cows with long AGD as compared to those with short AGD (Akbarinejad et al., 2019). Yet the mechanisms underlying this negative association between length of AGD and reproductive performance in bovine is not completely known (Gobikrushanth et al., 2017; Akbarinejad et al., 2019).

Postpartum uterine infections, including metritis and endometrosis, are considered as contributors to suboptimal fertility in cows by delaying uterine involution, rendering the uterus susceptible to chronic infections and causing ovarian dysfunction (Sheldon et al., 2006; Williams et al. 2007; Giuliodori et al., 2013; Sheldon and Owens, 2017). Furthermore, various postpartum items have been indicated as risk factors for postpartum uterine infections, including twinning birth, dystocia, retained fetal membranes, excessive calf birth weight and male offspring (Ghavi Hossein-Zadeh and Ardalan, 2011; Giuliodori et al., 2013). Nevertheless, to the best of our knowledge, there is no data available whether AGD is related to postpartum uterine infections and their corresponding risk factors.

Accordingly, this study was primarily designed to understand whether the reverse association of AGD with fertility in cows is attributable to different rates of postpartum reproductive complications among cows with various length of AGD. In addition, given that this study was carried out on Holstein dairy cows of different parities across various seasons, the effect of parity as well as season was also investigated in the present research.

Materials and Methods

Ethical statement and study design

This study was approved by Animal Ethics Committee at University of Tehran with respect to animal welfare and ethics (6/6/30854). The study was carried out at a commercial farm located in Tehran province from August, 2018 to March, 2019. Voluntary waiting period was 50 days in the herd and cows were subjected to insemination 12 hours after detection of standing heat. Estrus detection was performed thrice a day by visual observation for at least 30 minutes each time. All artificial inseminations were done by the same technician and insemination of sexed semen was merely performed in heifers. Pregnancy of cows was routinely diagnosed 40 to 45 days after insemination using rectal examination. The research plan of this study was to measure AGD period at the first postpartum examination of cows in order to associate AGD with reproductive parameters in dairy cows and the sample size of the study was 290 dairy cows.

Assessment of AGD

AGD was measured at the first examination postpartum (days 28 to 32 postpartum) by determining the distance from anus center to clitoris base by a digital caliper in millimeter (Hangzhou Instar Precision Machinery Co., Zhejiang, China). In total, AGD of dairy cows (n = 290) with different parities [primiparous (n = 90) and multiparous (n = 200) cows] over various seasons [spring (n = 15), summer (n = 28), fall (n = 115) and winter (n = 128)] were collected. Considering data of AGD length, cows were partitioned in three categories including short AGD (20% of cows with lowest values; n = 58), intermediate AGD (60% of cows with moderate values; n = 174) and long AGD (20% of cows with highest values; n = 58).

Nomenclature of reproductive parameters

Data associated with dystocia, twinning, retained fetal membranes (RFM), calf birth weight, offspring gender, puerperal metritis, clinical endometritis, days to first service (DFS) and first service conception rate (FSCR) were retrieved from herd database using individual ID number of cows. Sex ratio of offspring was defined as the proportion of male offspring (Gharagozlou et al., 2016). Cows were considered with dystocia when calf delivery could not proceed spontaneously and required assistance (Giuliodori et al., 2013; Sheldon and Owens, 2017). The cow was considered with retained fetal membranes when the fetal membranes were not expelled by 24 hours after commencement of parturition (Giuliodori et al., 2013; Sheldon and Owens, 2017). Puerperal metritis was defined as the presence of fetid watery red-brown uterine discharge during the first week postpartum (Sheldon et al., 2006). Clinical endometritis was defined as the presence of mucopurulent or purulent vaginal discharge at the time of first postpartum examination (Sheldon et al., 2006; Sheldon and Owens, 2017). DFS was the interval from calving to the first service postpartum (Akbarinejad et al. 2019, 2020). FSCR was the percentage of cows determined pregnant following the first service postpartum (Akbarinejad et al. 2019, 2020).

Statistical analysis

Continuous data (i.e., calf birth weight) were analyzed using generalized linear model (GLM) procedure. Binary data (i.e., rate of dystocia, twinning, RFM, puerperal metritis and clinical endometritis, sex ratio of offspring and FSCR) were analyzed using logistic regression by GENMOD procedure considering function link logit in the statistical model. Logistic regression analysis produced adjusted odds ratio (AOR) as the level of difference among various groups. DFS as a time-to-event variable was analyzed using LIFETEST procedure and the hazard of interval from calving to first service postpartum was analyzed using Cox regression by PHREG procedure. Cox regression analysis generated adjusted hazard ratio (AHR) as the conditional daily likelihood of the first service postpartum. AGD (short, intermediate and long AGD groups), parity (primiparous and multiparous cows) and season (spring, summer, fall and winter) were included as fixed effects in all statistical models. The LSMEANS statement was used to perform multiple comparisons. All analyses were conducted in SAS version 9.4 (SAS Institute Inc., Carry, NC, USA). Differences at $P < 0.05$ were considered statistically significant.

Results

AGD length in dairy cows

Mean ± standard error of mean (SEM), median, minimum and maximum of AGD length were 126.02 ± 0.80 mm, 126.00 mm, 75.64 mm and 178.20 mm, respectively, in investigated cows (n = 290; Figure 1). Statistics of AGD length in short, intermediate and long AGD categories are presented in Table 1.

Effect of AGD on reproductive parameters

Sex ratio of offspring was lower in short AGD group as compared with intermediate AGD group (AOR = 0.509; 95% CI = 0.261-0.990; *P* = 0.047) and long AGD (AOR = 0.418; 95% CI = 0.187-0.939; *P* = 0.035; Table 1). Furthermore, FSCR was higher in intermediate AGD group than short AGD (AOR = 2.526; 95% CI = 1.257-5.076; *P* = 0.009) and long AGD (AOR = 2.260; 95% CI = 1.159-4.407; *P* = 0.017) groups (Table 1). However, rate of dystocia, twinning, retained fetal membranes, calf birth weight, rate of puerperal metritis and clinical endometritis, hazard of first postpartum insemination and DFS did not differ among various AGD categories ($P > 0.05$; Table 1; Figure 2, A).

Effect of parity on reproductive parameters

Calf birth weight was greater in multiparous than primiparous cows (*P* = 0.032; Table 2). In addition, sex ratio of offspring was higher in multiparous cows as compared with primiparous cows (AOR = 2.300; 95% CI = 1.323-3.997; *P* = 0.003; Table 2). But rate of dystocia, twinning, retained fetal membranes, puerperal metritis and clinical endometritis, hazard of first postpartum insemination, DFS and FSCR was not different between primiparous and multiparous cows ($P > 0.05$; Table 2; Figure 2, B).

Effect of season on reproductive parameters

Calf birth weight was greater in winter than summer and fall ($P < 0.01$; Table 3). Moreover, rate of clinical endometritis was higher during summer as compared with fall (AOR = 3.006; 95% CI = 1.133-7.972; $P = 0.027$) and winter (AOR = 2.637; 95% CI = 1.025-6.784; $P = 0.044$; Table 3). Further, the hazard of first postpartum insemination was higher during spring than summer (AHR = 2.850; 95% CI = 1.327-6.119; $P = 0.007$; Figure 2, C), which culminated in shorter DFS during spring than summer ($P = 0.010$; Table 3). Additionally, FSCR was lower during summer as compared with spring (AOR = 0.120; 95% CI = 0.020-0.718; $P = 0.020$), fall (AOR = 0.123; 95% CI = 0.027-0.551; $P = 0.006$) and winter (AOR = 0.097; 95% CI = 0.022-0.433; $P = 0.002$; Table 3). Yet rate of dystocia, twinning, retained fetal membranes, sex ratio of offspring and rate of puerperal metritis did not differ among various seasons ($P > 0.05$; Table 3).

Discussion

The present study revealed that cows with intermediate length of AGD had superior conception rate at first postpartum insemination as compared to cows with short and long length of AGD; however, postpartum uterine infections and their contributing risk factors were not different among AGD categories. These findings implicate that the effect of AGD on fertility was not mediated through alteration in rate of postpartum complications. Previous studies merely reported suboptimal fertility of long AGD cows as compared to short AGD cows since in those studies, dairy cows were simply classified in two quantiles (Gobikrushanth et al., 2017; Akbarinejad et al., 2019). In this context, classification of cows into three AGD categories imparted this study the advantage to more accurately elucidate the relationship between AGD and reproductive competence in bovine. Given that prenatal exposure to androgens is the main determinant of AGD length (Gore et al., 2015; Kita et al., 2016), it could be surmised that under-exposure as well as over-exposure of fetus to androgens could lead to carry-over effects disrupting fertility of cows during adulthood, yet the corresponding underlying mechanisms remain to be unraveled by further studies.

Furthermore, the present study showed positive association between maternal AGD and sex ratio of calves. Likewise, proportion of male offspring has been reported to be higher in dams with larger AGD in mice, rabbit and porcine (Drickamer et al., 1997; Bánszegi et al., 2010; Szenczi et al., 2013), and the relationship between maternal AGD and sex ratio of offspring has been attributed to androgens (Edwards et al., 2016). In this regard, circulating and intrafollicular concentration of testosterone have been positively associated with sex ratio of offspring in bovine and non-bovine species (Grant and Irwin, 2005; Grant et al., 2008; Helle et al., 2008). Moreover, it has been suggested that this impact of testosterone is mediated through interaction of androgens with their receptor (Gharagozlou et al., 2016). Nevertheless, although positive correlation of AGD with circulating testosterone has been observed in human (Mira-Escolano et al., 2014), the correlation between AGD and plasma testosterone was weak and insignificant in dairy cows (Gobikrushanth et al., 2017). Yet, it is worth noting that the variety in androgen synthesis among cows with different length of AGD might be at paracrine level, which appears to play a determining role in terms of offspring sex allocation (Grant and Irwin, 2005; Grant et al., 2008), and it is not manifested at endocrine level.

Maternal parity also affected sex ratio of calves and proportion of female offspring was higher in primiparous than multiparous cows. Albeit the effect of parity on sex ratio of calves has been previously reported (Hossein-Zadeh, 2012), the substantial greater proportion of female calves in primiparous cows in the current study might have resulted from application of sexed semen in heifers in the herd rather than the effect of dam parity *per se*.

Moreover, it was observed that calves born to multiparous dams were heavier as compared with calves born to primiparous dams and this finding was in accord with results of previous studies (Akbarinejad et al., 2018). This observation could implicate dissimilar level of intrauterine nutrition between primiparous and multiparous dams since intrauterine nutrition is one of the main factors controlling offspring birth weight (Negrato and Gomes, 2013). To begin with, the parity-related variation in intrauterine nutrition could be attributed to differential nutritional partitioning between primiparous and multiparous cows owing to the fact that primiparous cows are still growing over the course of gestation and allocate part of their nutritional intake to their own development (Wathes et al., 2014). Alternatively, this phenomenon could have stemmed from less developed uterine vasculature and placenta, supplying the fetus with oxygen and nutrients (Browne et al., 2015), in primiparous than multiparous animals (Klewitz et al., 2015; Van Eetvelde et al., 2016; Robles et al., 2018).

Season of calving influenced offspring birth weight as well and calves born during summer and fall were lighter than calves born during winter. Given that during that the risk of heat stress is higher during warm seasons than cold seasons, the negative effect of summer and fall on offspring birth weight could be attributed to indirect exposure of fetus to heat stress during late stages of gestation, which are the most critical timeframes in terms of fetal growth, and in turn, neonatal birth weight (Akbarinejad et al., 2017). In corroboration of this notion, a previous study has also indicated adverse effects of maternal exposure to heat stress during late pregnancy on calf birth weight (Akbarinejad et al., 2017). Indeed, heat stress could diminish total placental and umbilical blood flow (Reynolds et al., 2006), compromise placental vascularization (Regnault et al., 2003; Reynolds et al., 2006), intensify placental resistance to oxygen, which would hinder transplacental oxygen diffusion and culminate in hypoxia (Regnault et al., 2003), and disrupt transport of nutrients to fetus (Regnault et al., 2005). Besides, heat stress decreases maternal dry matter intake, which could aggravate fetal nutritional restriction (Wheelock et al., 2010; Gorniak et al., 2014; Conte et al., 2018).

In addition, the present study showed higher rate of clinical endometritis during summer than fall and winter. By contrast, other studies investigating the prevalence of clinical endometritis across various seasons failed to detect any association between season of calving and occurrence of clinical endometritis (Lee et al., 2018). Regardless, heat stress might have contributed to the effect of summer on rate of clinical endometritis because heat stress could increase secretion of glucocorticoids, which suppress immune system and predispose the animal to various diseases including uterine infections (Bagath et al., 2019).

Eventually, it was observed that parturition in summer led to not only delayed first postpartum service but also diminished first service conception rate, which is consistent with the results of previous studies (Emadi et al., 2014; Akbarinejad et al., 2017; Hansen, 2019). The negative impact of summer on fertility might have also originated from heat stress given that heat stress postpones resumption of postpartum ovarian activity (Díaz et al., 2020), deteriorates heat detection rate (Emadi et al., 2014), impairs embryo development (Sakatani, 2017), decrease progesterone production and abrogate endometrial function (Wolfenson et al., 2000).

Conclusion

In conclusion, the present study showed that cows with intermediate length of AGD had greater reproductive performance at the first postpartum insemination as compared with their counterparts with shortest and longest lengths of AGD. Also, the probability of calf being male augmented as the length of AGD increased. Moreover, it was observed that sex ratio of offspring and calf birth weight were lower in primiparous than multiparous cows. Further, it was revealed that calves born during summer and fall had lighter birth weight and cows calved during summer were afflicted with higher rate of clinical endometritis, delayed first postpartum insemination and suboptimal first service conception rate.

Conflict of interest

The authors have no conflict of interest to declare.

References

Akbarinejad V., Gharagozlou F., Vojgani M., Ranji A. (2020). Evidence for quadratic association between serum anti-Müllerian hormone (AMH) concentration and fertility in dairy cows. Anim Reprod Sci, 218, 106457. https://doi.org/10.1016/j.anireprosci.2020.106457.

Akbarinejad V., Gharagozlou F., Vojgani M. (2017). Temporal effect of maternal heat stress during gestation on the fertility and anti-Müllerian hormone concentration of offspring in bovine. Theriogenology, 99, 69-78. http://dx.doi.org/10.1016/j.theriogenology.2017.05.018.

Akbarinejad V., Gharagozlou F., Vojgani M., Bagheri Amirabadi M. M. (2018). Nulliparous and primiparous cows produce less fertile female offspring with lesser concentration of anti-Müllerian hormone (AMH) as compared with multiparous cows. Anim Reprod Sci, 197, 222-230. http://dx.doi.org/10.1016/j.anireprosci.2018.08.032.

Akbarinejad V., Gharagozlou F., Vojgani M., Shourabi E., Makiabadi M. J. (2019). M. Inferior fertility and higher concentrations of anti-Müllerian hormone in dairy cows with longer anogenital distance. Domest Anim Endocrinol, 68, 47-53. http://dx.doi.org/10.1016/j.domaniend.2019.01.011.

Bagath M., Krishnan G., Devaraj C., Rashamol V. P., Pragna P., Lees A. M., Sejian V. (2019). The impact of heat stress on the immune system in dairy cattle: A review. Res Vet Sci, 126, 94-102. https://doi.org/10.1016/j.rvsc.2019.08.011.

Bánszegi O., Altbäcker V., Dúcs A., Bilkó A. (2010). Testosterone treatment of pregnant rabbits affects sexual development of their daughters. Physiol Behav, 101, 422-427. https://doi.org/10.1016/j.physbeh.2010.07.020.

Browne V. A., Julian C. G., Toledo-Jaldin L., Cioffi-Ragan D., Vargas E., Moore L. G. (2015). Uterine artery blood flow, fetal hypoxia and fetal growth. Philos Trans R Soc Lond B Biol Sci, 370, 20140068. https://doi.org/10.1098/rstb.2014.0068.

Conte G., Ciampolini R., Cassandro M., Lasagna E., Calamari L., Bernabucci U., Abeni F. (2018). Feeding and nutrition management of heat-stressed dairy ruminants. Ital J Anim Sci, 2018, 1–17. https://doi.org/10. 1080/1828051X.2017.1404944.

Díaz R. F., Galina C. S., Aranda E. M., Aceves L. A., Sánchez J. G., Pablos J. L. (2020). Effect of temperature – humidity index on the onset of post- partum ovarian activity and reproductive behavior in *Bos indicus* cows. Anim Reprod, 17, e20190074. http://doi.org/10.21451/1984-3143-AR2019-0074.

Drickamer L. C., Arthur R. D., Rosenthal T. L. (1997). Conception failure in swine: importance of the sex ratio of a female's birth litter and tests of other factors. J Anim Sci, 75, 2192-2196. https://doi.org/10.2527/1997.7582192x.

Edwards A., Cameron E., Wapstra E. (2016). Are there physiological constraints on maternal ability to adjust sex ratios in mammals? J Zool, 299, 1-9. https://doi.org/10.1111/jzo.12327.

Emadi S. R., Rezaei A., Bolourchi M., Hovareshti P., Akbarinejad V. (2014). Administration of estradiol benzoate before insemination could skew secondary sex ratio toward males in Holstein dairy cows. Domest Anim Endocrinol, 48, 110-118. https://doi.org/10.1016/j.domaniend.2014.03.001.

Gharagozlou F., Youssefi R., Vojgani M., Akbarinejad V., Rafiee G. (2016). Androgen receptor blockade using flutamide skewed sex ratio of litters in mice. Vet Res Forum, 7, 169-172.

Ghavi Hossein-Zadeh N., Ardalan M. (2011). Cow-specific risk factors for retained placenta, metritis and clinical mastitis in Holstein cows. Vet Res Commun, 35, 345-354. https://doi.org/10.1007/s11259-011-9479-5.

Giuliodori M. J., Magnasco R. P., Becu-Villalobos D., Lacau-Mengido I. M., Risco C. A., de la Sota R. L. (2013). Metritis in dairy cows: risk factors and reproductive performance. J Dairy Sci, 96, 3621-3631. https://doi.org/10.3168/jds.2012-5922.

Gobikrushanth M., Bruinjé T. C., Colazo M. G., Butler S. T., Ambrose D. J. (2017). Characterization of anogenital distance and its relationship to fertility in lactating Holstein cows. J Dairy Sci, 100, 9815-9823. https://doi.org/10.3168/jds.2017-13033.

Gore A. C., Chappell V. A., Fenton S. E., Flaws J. A., Nadal A., Prins G. S., Toppari J., Zoeller R. T. (2015). EDC-2: The Endocrine Society's Second Scientific Statement on Endocrine-Disrupting Chemicals. Endocr Rev, 36, E1-E150. https://doi.org/10.1210/er.2015-1010.

Gorniak T., Meyer U., Sudekum K. H., Danicke S. (2014) Impact of mild heat stress on dry matter intake, milk yield and milk composition in mid-lactation Holstein dairy cows in a temperate climate. Arch Anim Nutr, 68, 358–369. https://doi.org/10.1080/1745039X.2014.950451.

Grant V. J., Irwin R. J. (2005). Follicular fluid steroid levels and subsequent sex of bovine embryos. J Exp Zool A Comp Exp Biol, 303, 1120-1125. https://doi.org/10.1002/jez.a.233.

Grant V. J., Irwin R. J., Standley N. T., Shelling A. N., Chamley L. W. (2008). Sex of bovine embryos may be related to mothers' preovulatory follicular testosterone. Biol Reprod, 78, 812-815. https://doi.org/10.1095/biolreprod.107.066050.

Hansen P. J. (2019). Reproductive physiology of the heat-stressed dairy cow: implications for fertility and assisted reproduction. Anim Reprod, 16, 497-507. http://doi.org/10.21451/1984-3143-AR2019-0053.

Helle S., Laaksonen T., Adamsson A., Paranko J., Huitu O. (2008). Female field voles with high testosterone and glucose levels produce male-biased litters. Anim Behav, 75, 1031-1039. https://doi.org/10.1016/j.anbehav.2007.08.015.

Hossein-Zadeh N. G. (2012). Factors affecting secondary sex ratio in Iranian Holsteins. Theriogenology, 77, 214-219. https://doi.org/10.1016/j.theriogenology.2011.07.040.

Kita D. H., Meyer K. B., Venturelli A. C., Adams R., Machado D. L., Morais R. N., Swan S. H., Gennings C., Martino-Andrade A. J. (2016). Manipulation of pre and postnatal androgen environments and anogenital distance in rats. Toxicology, 368-369,152-161. https://doi.org/10.1016/j.tox.2016.08.021.

Klewitz J., Struebing C., Rohn K., Goergens A., Martinsson G., Orgies F., Probst J., Hollinshead F., Bollwein H., Sieme H. (2015). Effects of age, parity, and pregnancy abnormalities on foal birth weight and uterine blood flow in the mare. Theriogenology, 83, 721-729. https://doi.org/10.1016/j.theriogenology.2014.11.007.

Lee S. C., Jeong J. K., Choi I. S., Kang H. G., Jung Y. H., Park S. B., Kim I. H. (2018). Cytological endometritis in dairy cows: diagnostic threshold, risk factors, and impact on reproductive performance. J Vet Sci, 19, 301-308. https://doi.org/10.4142/jvs.2018.19.2.301.

Mira-Escolano M. P., Mendiola J., Mínguez-Alarcón L., Roca M., Cutillas-Tolín A., López-Espín J. J., Torres-Cantero A. M. (2014). Anogenital distance of women in relation to their mother's gynaecological characteristics before or during pregnancy. Reprod Biomed Online, 28, 209-215. https://doi.org/10.1016/j.rbmo.2013.09.026.

Negrato C. A., Gomes M. B. (2013). Low birth weight: causes and consequences. Diabetol Metab Syndr, 5, 49. https://doi.org/10.1186/1758-5996-5-49.

Regnault T. R. H., de Vrijer B., Galan H. L., Davidsen M. L., Trembler K. A., Battaglia F. C., Wilkening R. B., Anthony R. V. (2003). The relationship between transplacental O2 diffusion and placental expression of PIGF, VEGF and their receptors in a placental insufficiency model of fetal growth restriction. J Physiol, 550, 641-656. https://doi.org/10.1113/jphysiol.2003.039511.

Regnault T. R. H., Friedman J. E., Wilkening R. B., Anthony R. V., Hay W. W. Jr. (2005). Fetoplacental transport and utilization of amino acids in IUGR—A review. Placenta, 26, S52-S62. https://doi.org/10.1016/j.placenta.2005.01.003.

Reynolds L. P., Caton J. S., Redmer D. A., Grazul-Bilska A. T., Vonnahme K. A., Borowicz P. P., Luther J. S., Wallace J. M., Wu G., Spencer T. E. (2006). Evidence for altered placental blood flow and vascularity in compromised pregnancies. J Physiol, 572, 51-58. https://doi.org/10.1113/jphysiol.2005.104430.

Robles M., Dubois C., Gautier C., Dahirel M., Guenon I., Bouraima-Lelong H., Viguié C., Wimel L., Couturier-Tarrade A., Chavatte-Palmer P. (2018). Maternal parity affects placental development, growth and metabolism of foals until 1 year and a half. Theriogenology, 108, 321-330. https://doi.org/10.1016/j.theriogenology.2017.12.019.

Sakatani M. (2017). Effects of heat stress on bovine preimplantation embryos produced in vitro. J Reprod Dev, 63, 347-352. https://doi.org/10.1262/jrd.2017-045.

Sheldon I. M., Lewis G. S., LeBlanc S., Gilbert R. O. (2006). Defining postpartum uterine disease in cattle. Theriogenology, 65, 1516-1530. https://doi.org/10.1016/j.theriogenology.2005.08.021.

Sheldon I., Owens S. E. (2017). Postpartum uterine infection and endometritis in dairy cattle. Anim Reprod, 14, 622-629. https://doi.org/10.21451/1984-3143-AR1006.

Szenczi P., Bánszegi O., Groó Z., Altbäcker V. (2013). Anogenital distance and condition as predictors of litter sex ratio in two mouse species: a study of the house mouse (*Mus musculus*) and mound-building mouse (*Mus spicilegus*). PLoS One, 8, e74066. https://doi.org/10.1371/journal.pone.0074066.

Thankamony A., Pasterski V., Ong K. K., Acerini C. L., Hughes I. A. (2016). Anogenital distance as a marker of androgen exposure in humans. Andrology, 4, 616-625. https://doi.org/10.1111/andr.12156.

Van Eetvelde M., Kamal M. M., Hostens M., Vandaele L., Fiems L. O., Opsomer G. (2016). Evidence for placental compensation in cattle. Animal, 10, 1342-1350. https://doi.org/10.1017/S1751731116000318.

Wathes D. C., Pollott G. E., Johnson K. F., Richardson H., Cooke J. S. (2014). Heifer fertility and carry over consequences for life time production in dairy and beef cattle. Animal, 8, 91-104. https://doi.org/10.1017/S1751731114000755.

Wheelock J. B., Rhoads R. P., Vanbaale M. J., Sanders S. R., Baumgard L. H. (2010). Effects of heat stress on energetic metabolism in lactating Holstein cows. J Dairy Sci, 93, 644-655. https://doi.org/10.3168/jds.2009-2295.

Williams E. J., Fischer D. P., Noakes D. E., England G. C., Rycroft A., Dobson H., Sheldon I. M. (2007). The relationship between uterine pathogen growth density and ovarian function in the postpartum dairy cow. Theriogenology, 68, 549-559. https://doi.org/10.1016/j.theriogenology.2007.04.056.

Wolfenson D., Roth Z., Meidan R. (2000). Impaired reproduction in heat-stressed cattle: basic and applied aspects. Anim Reprod Sci, 60-61, 535-537. https://doi.org/10.1016/S0378-4320(00)00102-0.

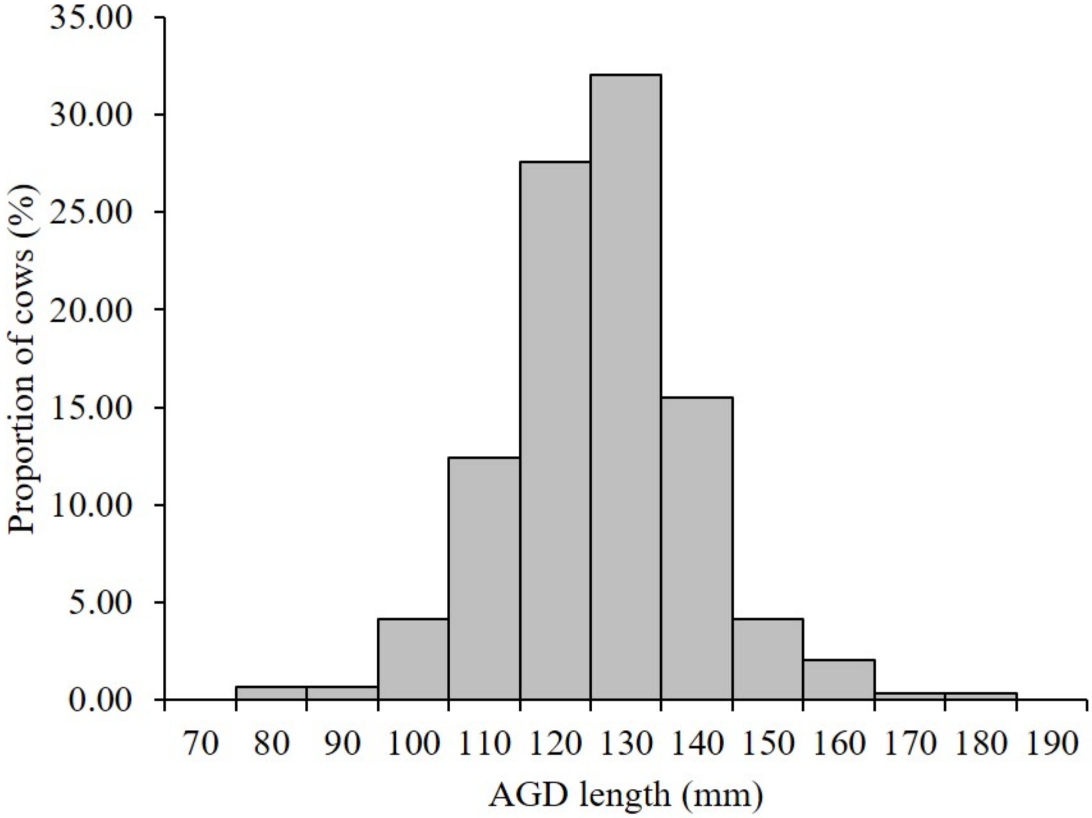

Figure 1. Histogram of frequency distribution regarding length of AGD in Holstein dairy cows (n = 290).

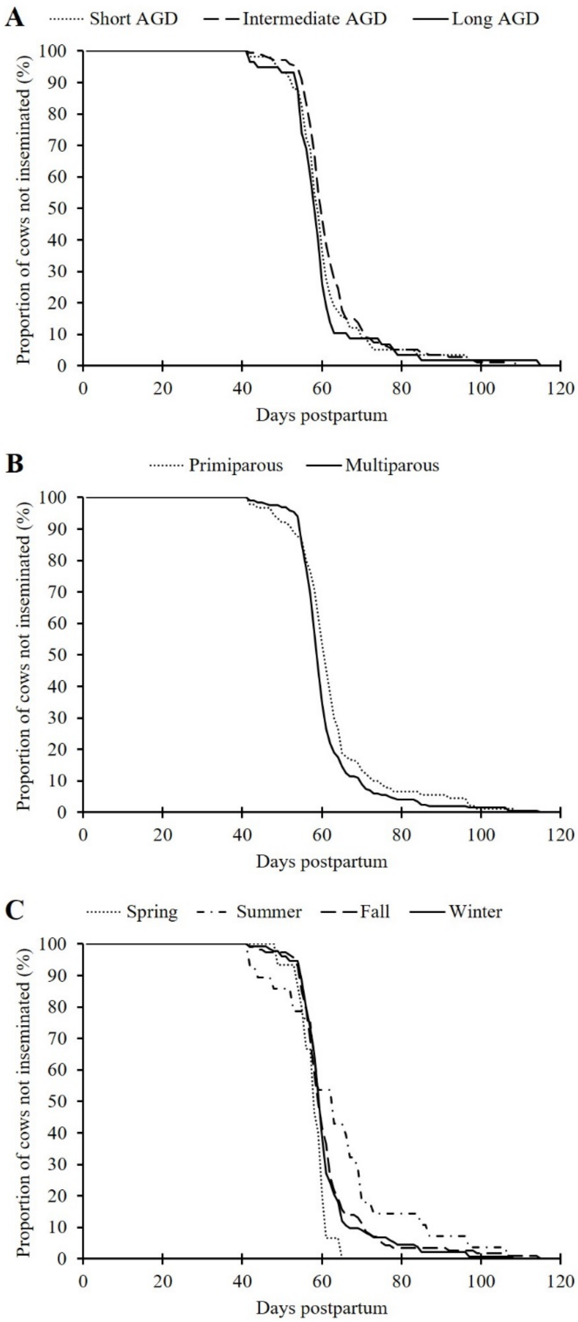

Figure 2. A) Time to first service postpartum in short (n = 58), intermediate (n = 174) and long (n = 58) AGD cows. B) Time to first postpartum insemination in primiparous (n = 90) and

multiparous (n = 200) cows. C) Time to first postpartum insemination in cows during spring (n =15), summer (n = 28), fall (n = 115) and winter (n = 132).

DOI: 10.22059/IJVM.2020.309538.1005125 Iranian Journal of Veterinary Medicine Original Article

Online ISSN: 2252-0554

عملکرد تولیدمثلی بهتر گاوهای شیری هلشتاین با طول فاصله آنوجنیتال متوسط در تلقیح اول پس از زایش

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چکیده

زمینه مطالعه: مطالعات پیشین مبین رابطه منفی فاصله آنوجنیتال با باروری در گاوها است، اما مکانیسم این رابطه معکوس به طور کامل مشخص نیست. در این رابطه، عفونت‌های رحمی پس از زایش و عوامل مخاطره مرتبط با این عفونت‌ها می‌توانند سبب کاهش باروری گاوها گردند، ولی هیچ پژوهشی تا به حال به بررسی ارتباط فاصله آنوجنیتال و مشکلات پس از زایش نپرداخته است.

هدف: مطالعه حاضر به منظور بررسی رابطه فاصله آنوجنیتال با عملکرد تولیدمثلی پس از زایش در گاوهای شیری به انجام رسید.

روش کار: فاصله آنوجنیتال گاوها (تعداد = 290) همزمان با اولین معاینه پس از زایش به میلی‌متر اندازه‌گیری شد. گاوها بر اساس طول فاصله آنوجنیتال به سه دسته شامل فاصله آنوجنیتال کوتاه (20٪ جمعیت گاوها دارای کمترین مقادیر)، فاصله آنوجنیتال متوسط (60٪ جمعیت گاوها دارای مقادیر متوسط) و فاصله آنوجنیتال بلند (20٪ جمعیت گاوها دارای بیشترین مقادیر) تقسیم‌بندی شدند. به‌علاوه، داده‌های متغیرهای تولیدمثلی پس از زایش از پایگاه داده گله بازیابی شدند. داده‌ها با استفاده از نرم‌افزار SAS ویرایش شماره 9/4 آنالیز شدند.

نتایج: نرخ سخت‌زایی، دوقلوزایی و جفت‌ماندگی، متریت پس از زایش و آندومتریت بالینی، وزن تولد گوساله و فاصله زایش تا اولین تلقیح در میان دسته‌های مختلف فاصله آنوجنیتال متفاوت نبود ($P > 0/05$). اما، درصد موالید نر در گاوهای با فاصله آنوجنیتال کوتاه نسبت به گاوهای با فاصله آنوجنیتال متوسط و بلند کمتر بود ($P < 0/05$). علاوه بر این، نرخ باروری در تلقیح اول پس از زایش در گروه فاصله آنوجنیتال متوسط بالاتر از گروه‌های فاصله آنوجنیتال کوتاه و بلند بود ($P < 0/05$).

نتیجه‌گیری: در نتیجه، مطالعه حاضر بیانگر نرخ آبستنی در اولین تلقیح پس از زایش نامناسب در گاوهای دارای حداقل و حداکثر طول فاصله آنوجنیتال بود و نشان داد که این باروری کمتر از طریق تغییر در نرخ مشکلات تولیدمثلی پس از زایش حاصل نشده بود.

واژه‌های کلیدی: فاصله آنوجنیتال؛ گاو شیری؛ سخت زایی؛ باروری؛ عفونتهای رحمی