



PRENATAL STRESS AND PUPPIES:

Implications for dog welfare in commercial-breeding kennels

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Introduction

Many dogs in commercial breeding (CB) kennels exhibit fear in response to novel stimuli (Pritchett et al., 2021; Stella et al., 2019). Experiencing chronic fear reduces welfare (Beerda et al., 1997). To minimize fear in dogs and to avoid or reduce chronic fear it is important to understand factors that contribute to its development and identify effective interventions. These include aspects that can be directly controlled by breeders, such as the dog's socialization, handling, and routine management. Other variables are indirectly controlled by breeders. For example, maternal factors, such as genetics (Arvelius et al., 2014; Goddard & Beilharz, 1982; Iliska et al., 2017) and maternal care (Foyer et al., 2016; Tiira & Lohi, 2015) can affect how puppies respond to fear-inducing, stressful situations. Prenatal stress may have similar effects, based on studies conducted in other species (Bjarne O. Braastad, 1998). Prenatal stress is often overlooked and should be considered when developing strategies to improve dam and puppy welfare.

What is prenatal stress, and how does it affect offspring?

Prenatal stress has been defined as "traumatic life events, stressful situations/ experiences, subsequent perceptions of stressors, or the resulting phenotypes of stressors (e.g., anxiety) that a mother experienced during pregnancy" (Sosnowski et al., 2018). Prenatal stress poses a welfare risk for both dams and their puppies because it has been associated with adverse outcomes, including increased fear (Champagne & Meaney, 2006; Schneider, 1992; Thompson, 1957), abnormal behaviors (Schneider, 1992), stereotypic behaviors (Wilson et al., 2013), overactive stress responses (Barbazanges et al., 1996; Smith et al., 2004), reduced birthweights (Patin et al., 2002), increased stillbirths (Wisborg et al., 2008), premature births (Lilliecreutz et al., 2016), and compromised immune function (Merlot et al., 2008). Therefore, prenatal stress should be minimized whenever possible.

How does prenatal stress change offspring behavior and physiology?

Prenatal stress may cause changes in dams that alter the behavior and physiology of their offspring via epigenetic mechanisms (Darnaudéry & Maccari, 2007; Sosnowski et al., 2018). Epigenetic mechanisms are those that cause a change in gene expression, rather than the genetic coding itself (Darnaudéry & Maccari, 2007). In rats, prenatal stress has been shown to negatively impact dams' nursing positions, and it reduces durations of maternal behaviors such as gathering, sniffing, licking, and grooming (Champagne & Meaney, 2006; Patin et al., 2002; Smith et al., 2004). These changes in maternal care are associated with decreases in offspring exploratory behavior which may impact fear and physiological responses to stress that continue into adulthood (Champagne & Meaney, 2006; Smith et al., 2004). Secondly, prenatal stress in dams can impact the mother's own stress hormones. For example, Barbazanges et al. (1996) found that prenatally-stressed rats produced high concentrations of corticosterone, a stress hormone associated with the "fight or flight" response, and gave birth to pups that also showed overactive stress responses. Thus, prenatal stress can trigger changes in maternal behavior and hormones, resulting in alterations in offspring gene expression, behavior and physiology.

What do we know about prenatal stress in dogs?

There is relatively little published information about the effects of prenatal stress in dogs. In blue foxes, which are closely related to domestic dogs, pups of prenatally stressed vixens exhibited behavioral reactivity through biting, escape attempts, and aggressive behavior in response to stress (Braastad, Osadchuk, Lund, & Bakken, 1998). Their physiological responses also suggested an overactive stress response (Braastad et al., 1998). Given these findings, it is plausible that prenatal stress may similarly have a permanent impact on a puppy's response to stress (Haug, 2008).

Recent studies suggest that changes in maternal care can have an impact on puppies' behaviors (Bray et al., 2017; Foyer et al., 2016; Guardini et al., 2016, 2017; Tiira & Lohi, 2015). However, more research is needed to determine if prenatal stress can impair maternal care in dogs, as has been seen in other species.

Overall, more research must be conducted with dogs to determine the role prenatal stress plays in affecting puppy welfare. However, based on evidence in other species which shows that minimizing prenatal stress produces



positive outcomes, every effort to minimize prenatal stress in dams should be made.

How can understanding of prenatal stress improve welfare in CB kennels?

There are many practical ways for commercial breeders to minimize prenatal stress in dams. For example, breeders can relocate pregnant dams from their home pens to whelping pens for the last several weeks of pregnancy (Johnson, 2008). This will help them to acclimate to their environments and minimize stress during whelping. In addition, breeders can reduce the potential for pregnant bitches to experience significant stress by ensuring that whelping pens are located in quiet areas with minimal disruptions. They can also ensure that dogs are not transported unless necessary for veterinary purposes (Canadian Veterinary Medical Association, 2018) and that they are provided with consistent, gentle handling exclusively from familiar caretakers.

In addition to minimizing stressors, breeders should pay attention to the temperament of breeding females. Dams with fearful temperaments are more likely to perceive novel stimuli negatively (Serpell & Hsu, 2001) and therefore are more likely to experience prenatal stress. As previously noted, these dams are more likely to have fearful offspring (Arvelius et al., 2014; Goddard & Beilharz, 1982; Ilksa et al., 2017). These dogs in turn may become breeding females, therefore perpetuating the prenatal stress cycle of negative impacts.

Conclusion

Although there is no direct evidence in dogs, current literature in other species has demonstrated a relationship between prenatal stress and welfare. Prenatal stress not only has the potential to impair dam welfare but impacts offspring welfare as well. Therefore, strategies to reduce prenatal stress should be employed to support dam and puppy welfare in CB kennels.

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