

# Non-Nutritive Suck (NNS) and Ano-genital Distance (AGD): Examining the Developmental Effects of Environmental Exposure in a Puerto Rican Infant Cohort



Morgan Hines, Emily Zimmerman, PhD, CCC-SLP; Gredia Huerta Montañez, MD;  
 Akram Alshawabkeh, PhD; Carmen Vélez Vega, PhD, Zaira Rosario Pabón, MS

## Background

At the Center for Research on Early Childhood Exposure and Development (CRECE) in Puerto Rico, researchers seek to understand how environmental exposures affect infant development in their cohort (n=320). In this cohort, Non-Nutritive Suck (NNS), a measure of an infant's sucking skill, is currently being established as a rapid measure of infant neurodevelopment, and we hope to associate NNS with developmental outcomes [1, 2].

It is also established that early childhood exposure to phthalates, a substance used in plastics, may affect development [3]. Because of this relationship between phthalate exposure and development, the center also collects ano-genital distance (AGD), ano-scrotal distance (ASD) and ano-fourchette distance (AFD) measurements which are used as a direct measure of phthalate exposure. Phthalate exposure inversely affects the length of AGD, ASD and AFD, so the lower these measures, the higher the infant's exposure to phthalates.

## Abstract

Currently, AGD, ASD, and AFD are used as measures, representative of phthalate exposure levels. However, given that phthalate exposure affect development and we hope to develop NNS as a measure of neurodevelopment, the aim of this preliminary study was to determine if there is a relationship between NNS and AGD, ASD, and/or AFD. These measurements were sampled and measured from (n=38, n=21 males, 17 females) 4-6 week old infants. After conducting preliminary statistical analyses, AGD, AFD, and ASD were significantly correlated with NNS frequency in males. We will continue examining the relationship between these variables as well as others relevant to development.

## Acknowledgements

I want to thank Dr. Emily Zimmerman, Dr. Huerta-Montanez, Dr. Alshawabkeh, Dr. Vélez Vega, Zaira and the teams at The Center for Research on Early Childhood Exposure and Development in Puerto Rico (CRECE) and the Research Opportunities for Undergraduates: Training in Environmental Health Sciences (ROUTES) program offices.

## Methods and Data

The NNS measurements used in this study were average duration, frequency, height, area under the peak, bursts per minute, cycles per burst, and cycles per minute. Each of these variables was compared to AGD, AFD, and ASD measurements for the cohort through bivariate correlations. There were statistically significant correlations between average frequency (P=0.025, R=-0.500) and area under the peak (P=0.014, R=0.540) for male AGDs, and bursts per minute in female AFD measurements (P=0.025, R=-0.541).

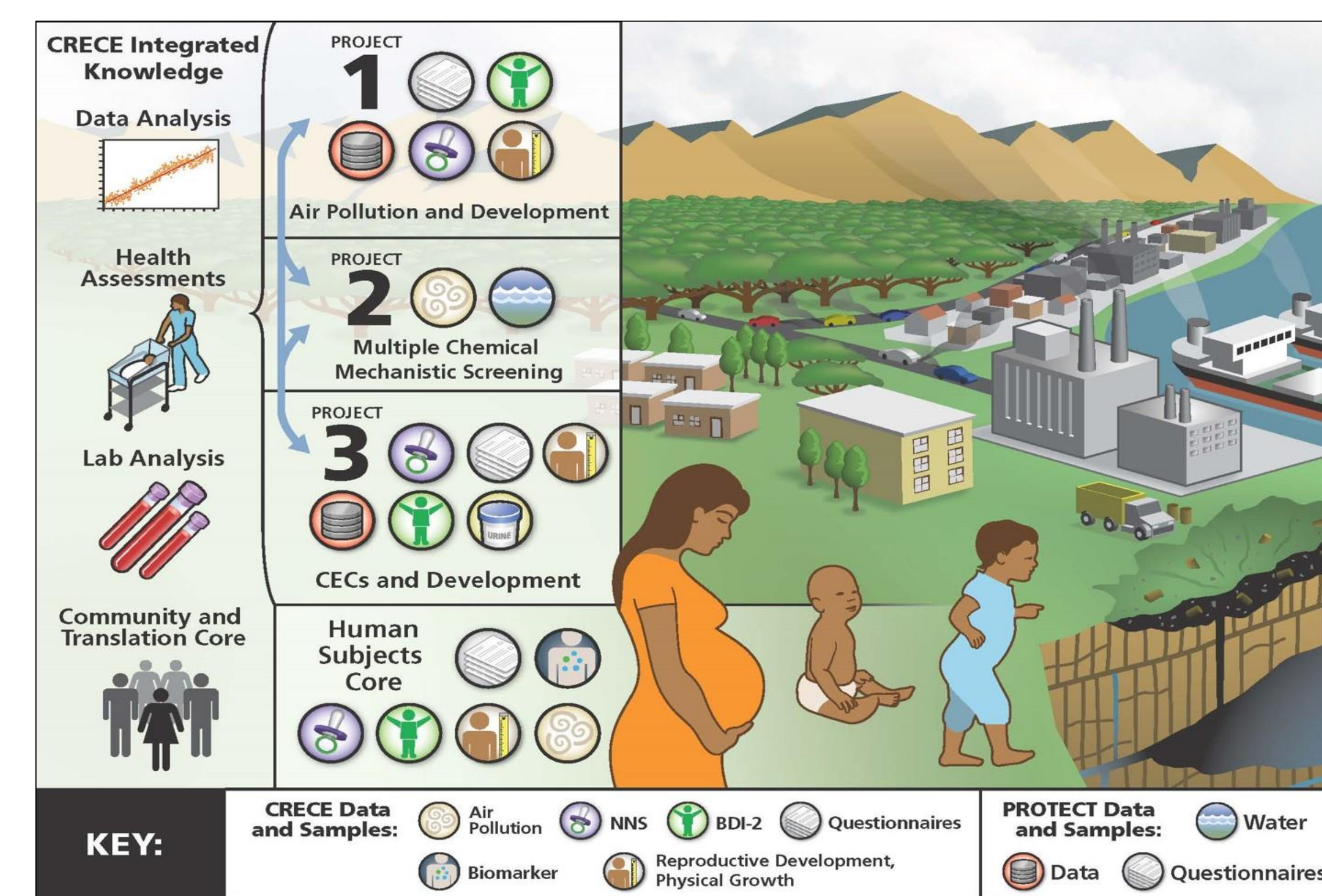


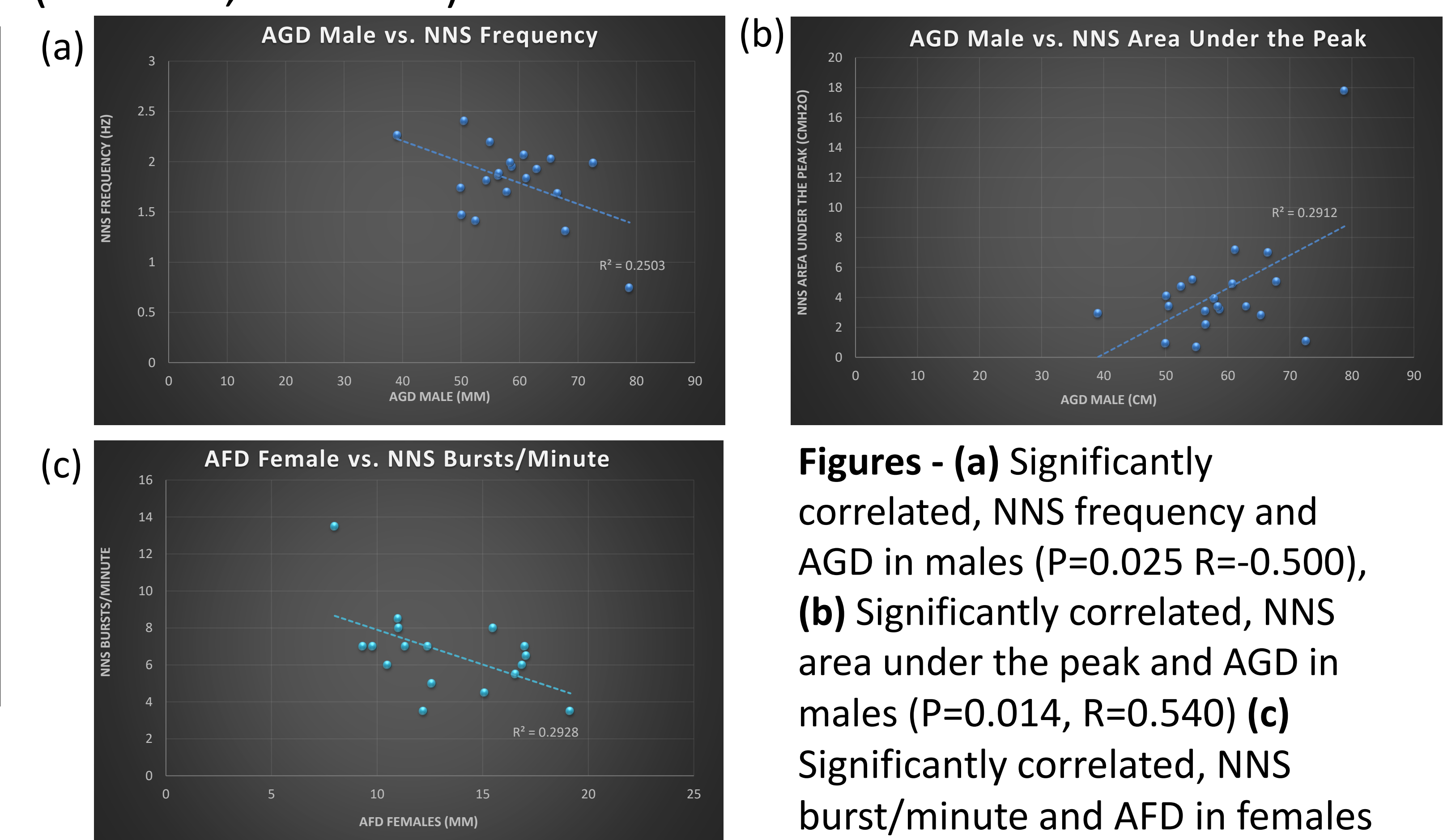
Figure 1 – CRECE study methodology.

## Conclusions

Decreased AGD measures indicate increased phthalate exposure [3,4]. For males, the higher the phthalate exposure, the faster their NNS frequency or sucking speed, and the lower the average area under the peak or amplitude of their suck. For females, when the phthalate exposure was high, the number of bursts per minute increased. The results demonstrate that there is a significant relationship between NNS measures and AGD and AFD, and that how phthalates affect infant development could vary based on gender. This result also indicates that phthalates may be influencing infant neural and suck development through physiological pathways that affect suck pressure and speed. However, to better understand these relationships, more infants should be incorporated into the study. Additionally, there are other NNS variables like non-NNS behaviors that can be extracted from existing data and examined in relation to AGD, ASD, and AFD.

## References

- [1] Wolhuis-Stigter, M. I., Da Costa, S. P., Bos, A. F., Krijnen, W. P., Van Der Schans, C. P., & Luinge, M. R. (2017). Sucking behaviour in infants born preterm and developmental outcomes at primary school age. *Dev Med Child Neurol*, 59(8), 871-877. doi:10.1111/dmcn.13438
- [2] Wolhuis-Stigter, M. I., Luinge, M. R., da Costa, S. P., Krijnen, W. P., van der Schans, C. P., & Bos, A. F. (2015). The association between sucking behavior in preterm infants and neurodevelopmental outcomes at 2 years of age. *J Pediatr*, 166(1), 26-30. doi:10.1016/j.jpeds.2014.09.007
- [3] Meeker, J., Sathyanarayana, S., & Swan, S. (2009). Phthalates and other additives in plastics: Human exposure and associated health outcomes. *Philosophical Transactions Of The Royal Society B-Biological Sciences*, 364(1526), 2097-2113.
- [4] Swan, S., Main, K., Liu, F., Stewart, S., Kruse, R., Calafat, A., . . . Teague, J. (2005). Decrease in Anogenital Distance among Male Infants with Prenatal Phthalate Exposure. *Environmental Health Perspectives*, 113(8), 1056-1061.



**Figures - (a)** Significantly correlated, NNS frequency and AGD in males (P=0.025 R=-0.500), **(b)** Significantly correlated, NNS area under the peak and AGD in males (P=0.014, R=0.540) **(c)** Significantly correlated, NNS burst/minute and AFD in females (P=-0.025, R=-0.541)