Uterine Position Effect in Fetal Growth Pattern of Nanopolysterene-Exposed Rats

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Background

- Plastics are ubiquitous in our modern world because of their cost-effectiveness and easy production, but they can take from 5 to several thousand years to completely degrade, making them a growing issue in our environment.[1]
- It is known that plastics can fragment into smaller pieces, such as microplastics (<5 mm in one dimension) and nanoplastics (<100 nm in one dimension).[2]
- We are exposed to micro- and nanoplastics through the air and products we consume/use everyday (such as bottled water, salt, synthetic clothing, etc.), making inhalation and ingestion important routes of exposure.[3,4]
- Toxicity has been identified for micro- and nanoplastics, including a correlation between size and penetration into tissues (smaller particles reaching deeper).[4]
- Nanoplastics can translocate to other tissues different to the exposure site, including from maternal tissues to the fetal compartment, making nanoplastics a danger to healthy fetal development, which can have both individual and generational consequences.[5]
- The uterine position of the fetuses in rodent models might play in a role in their growth pattern, making this an important variable to take into consideration.[6]
- **In this study, we hypothesize that rat fetuses exposed to nanopolysterene during gestation have a lower average weight than controls and that fetuses implanted in the middle of the uterine horn will have a higher average weight than those in the ovarian and vaginal ends.**

Methods

- **Nanopolystyrene Characterization** – 20 nm Rhodamine-labeled polystyrene beads were ordered (NanoCS) and particle size confirmed.
- **Nanopolysterene Exposure** – Pregnant rats were exposed to nanopolysterene particles (2.64 x 10^{14} particles) through intratracheal instillation (300 µL) at gestational day (GD) 19. A control group was treated with saline solution at GD 19.
- **Fetal Weight Data Recollection and Analysis** – Pregnant rats (both controls and exposed) were sacrificed at GD 20. The anatomical uterine position of the fetuses was identified, and their weights were measured and recorded. The data of was analyzed (GraphPad, Inc.) to determine if there was significant difference ($p<0.05$) between controls and exposed rats and between the different anatomical uterine positions (ovarian end, middle and vaginal end).

Experimental Design

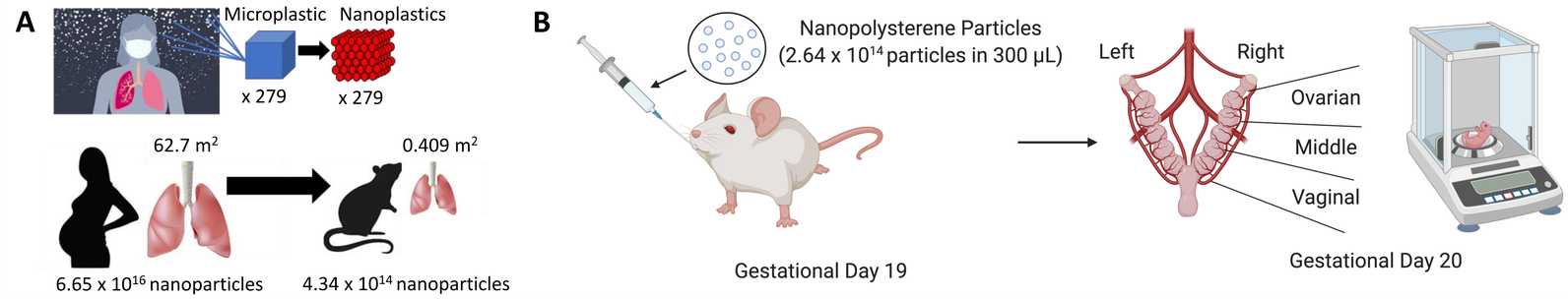

Fig. 1. A) Polystyrene Nanoplastic Exposure Dosimetry – Our exposure dose is 2.64 x 10^{14} particles, which is lower than the calculated exposure of 4.34 x 10^{14} particles. **B) Intratracheal Instillation and Data Recollection** – GD 19 rats were instilled intratracheally the nanoparticle treatment or saline solution. On GD 20, the rats were sacrificed, the anatomical uterine positioning of the fetuses was determined, and their weights were measured.

Results

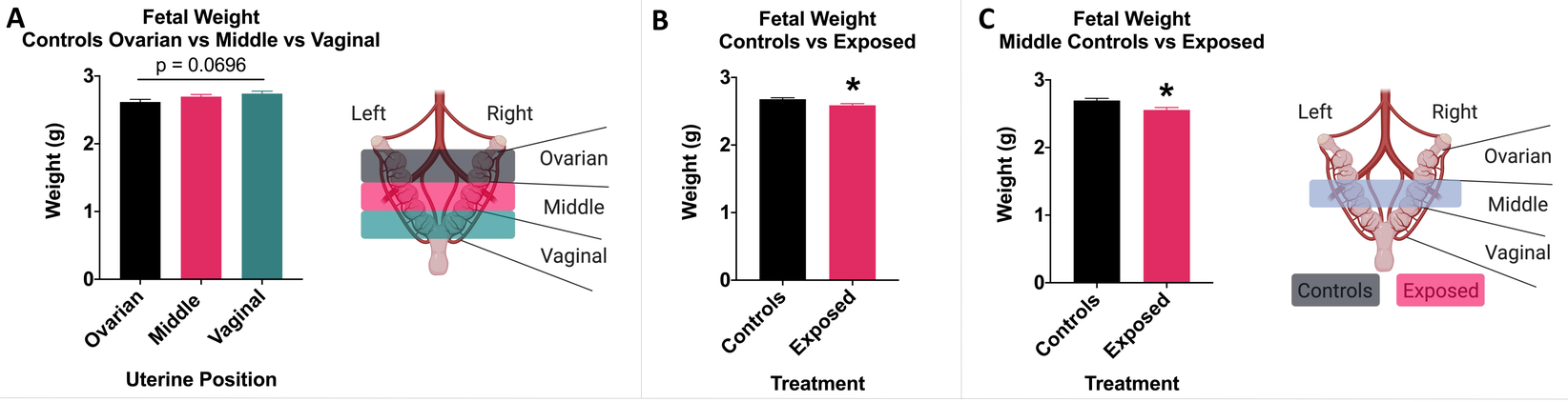

Fig. 2. A) Fetal Weight: Controls Ovarian vs Middle vs Vaginal - Average weights of fetuses from control dams from each section of the uterine horn (ovarian, middle and vaginal) were compared. Data are presented as means ± SE. The highest average weight between the three sections was the vaginal end (2.74 ± 0.04 g). This was followed by the middle section (2.70 ± 0.03 g) and the ovarian end (2.62 ± 0.04 g). Although there seems to be a trend of decreasing average weight from the vaginal to the ovarian end ($p=0.08$), this is not yet to significance. **B) Fetal Weight: Controls vs Exposed** – Average weights of fetuses from control and exposed dams were compared. Data are presented as means ± SE. The average weight of controls fetuses (2.68 ± 0.02 g) was significantly higher ($p=0.0051$) than the average weight of exposed fetuses (2.59 ± 0.02 g). **C) Fetal Weight: Middle Controls vs Exposed** – Average weights of fetuses from the middle section of the uterine horns of both control and exposed dams were compared. Data are presented as means ± SE. The average weight of controls fetuses from the middle section (2.70 ± 0.03 g) was significantly higher ($p=0.005$) than the average weight of exposed fetuses from the same section (2.56 ± 0.04 g).

Conclusion & Future Goals

- Contrary to our hypothesis, the highest average weight by anatomical uterine positioning was observed in fetuses (controls) from the vaginal end, although this is not yet to significance.
- As hypothesized, the average weight of fetuses from rats exposed to nanopolysterene was significantly lower than the average weight of control fetuses. This seems to be happening by differences in the middle section of the uterine horn, as the exposed fetuses from the middle horn had a significantly lower average weight than their control counterparts, which was not observed in other uterine sections.
- Our next step would be identifying the mechanisms behind the differences observed, which we hypothesize have to do with changes in vasculature.

References

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