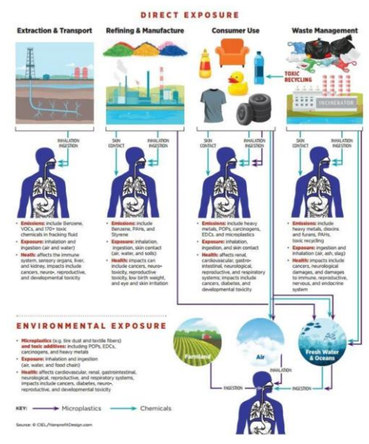
A preliminary study for identifying correlation polystyrene microplastics with sperm quality in the mouse.

Bum Sik Tae, Jung Wan Yoo, Jae Young Park, Jae Hyun Bae

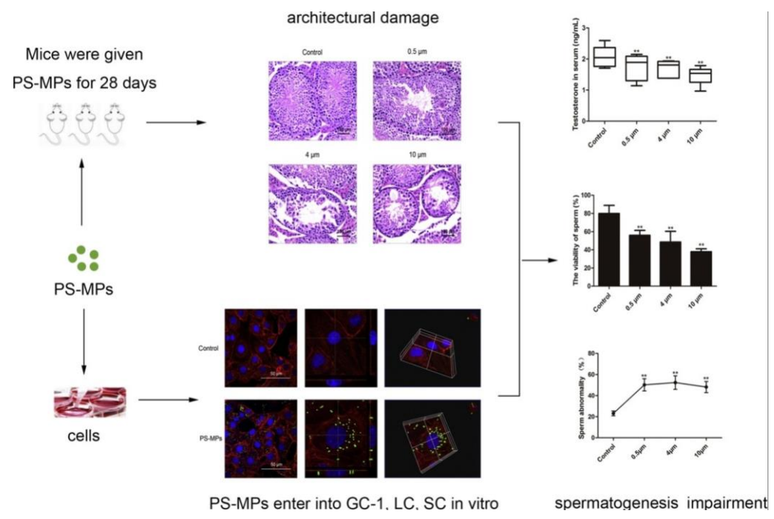
Department of Urology, Korea University Ansan Hospital, Korea University College of Medicine, Ansan, Korea

Introduction



Due to the problematic degradation properties of plastics, the decomposition of plastic results in the formation of numerous microplastics (MPs), less than 5 mm in diameter.

These MPs enter the soil and the ocean, eventually passing through the air, water, or food chain back to the human body and harming human health.



Animal experimental studies have been conducted to investigate the association between microplastics (MPs) and male infertility.

However, studies documenting the potential health risks of microplastics to the reproductive system, particularly in male mammals, remain limited.

Therefore, data on the effects of microplastics on the male reproductive system using mammalian models are needed for the human health risk assessment of microplastics.

In this study, we aimed to comprehensively examine the toxic effects of polystyrene microplastics (PS-MPs) on the male reproductive system of rats through in vivo and in vitro experiments.

Methods

Thirty C57BL/6 male mice were randomly allocated to six equally sized groups.

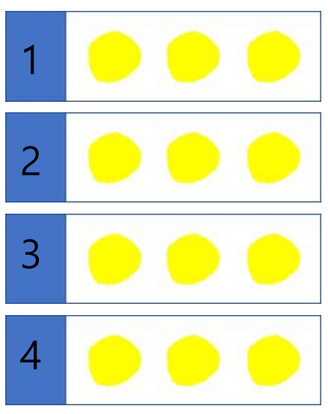
Mice were exposed to Fluorescence polystyrene microparticles (5μm <18%, PS-MPs, Green) at a dose of 0 (control), 1mg/dl, 3mg/dl by oral gavage for 28 and 56 days.

At the 28th and 56th day, blood samples were collected for biochemical analysis and testis, the gastrointestinal tract, liver, lung and kidneys were removed from each rat for Fluorescence polystyrene microparticles detection and western blot.

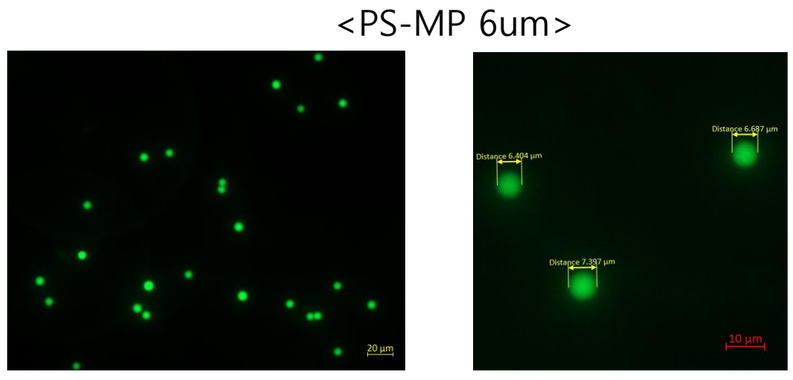
Sperm quality, epididymal morphology, expressions of inflammatory markers, and expression in testicular tissues, and expressions of BTB junction proteins were detected.

Fluorescence polystyrene microparticles (PS-MPs) (green) , 6~7um
Oral gavage
Group
① Control_1M (n=5) (1,2,3,4,5)
② Fluorescence PS-MPs 1mg/d_1M (n=5) (11,12,13,14,15)
③ Fluorescence PS-MPs 3mg/d_1M (n=5) (21, 22, 23, 24, 25)

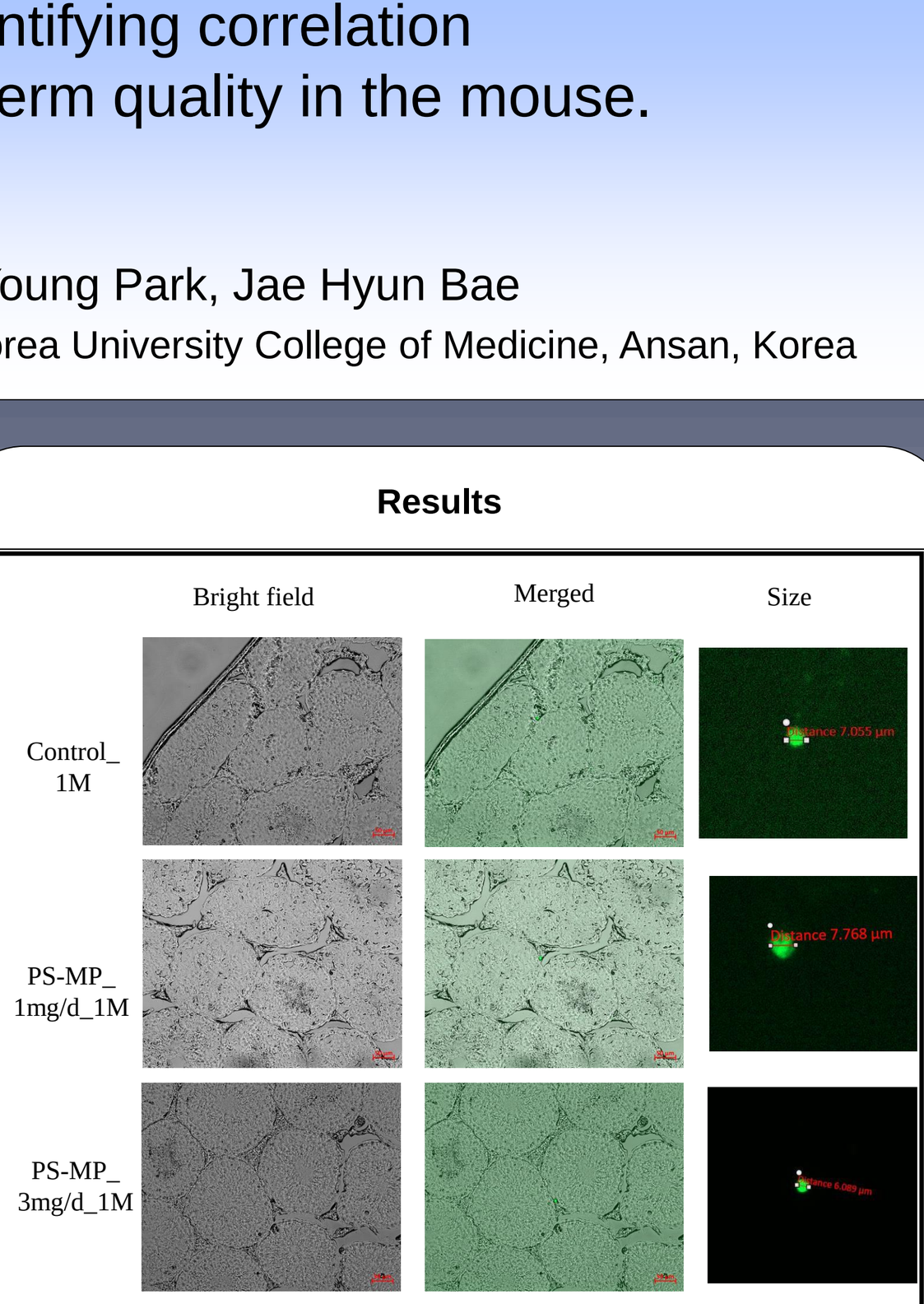
- Frozen section
- Tissue : Liver (10um), Kidney (10um), Testis (7um)
- 7~10um thickness // serial section (total 18~21 section)



<PS-MP 6um>



Results



The results indicated that after exposure for 28days and 56 days, PS-MPs was detected in the testis of mice.
The smallest PS-MPs had a size of 5.870 μm, and the largest size was observed up to 7.064 μm.

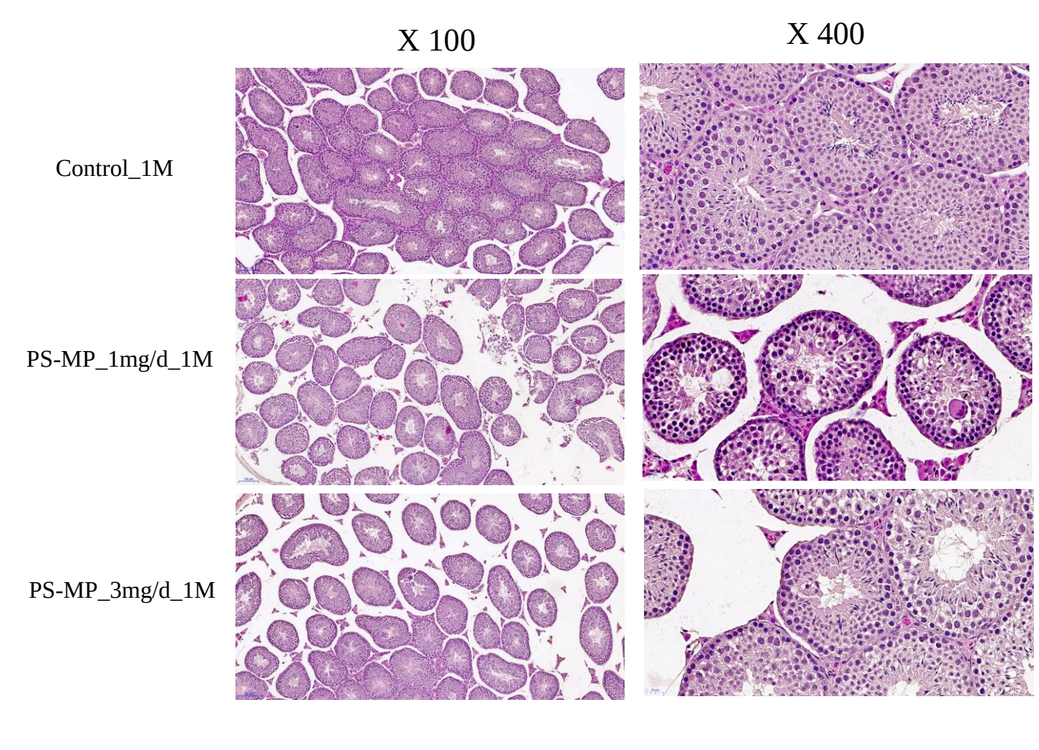


Table. Outcome of male mouse sperm analysis after polystyrene microparticles exposure.

1 Month	Control	PS-MP 1mg/dl	PS-MP 3mg/dl	P-value*
Count (x 10^6/mL)	14.74±2.81	14.48±6.83	15.54±11.01	0.125
Abnormality rate (%)	3.98±2.26	12.36±12.36 **	13.80±10.16 **	0.134
Motility rate (%)	14.32±5.93	15.66±7.95	14.18±9.67	0.958
2 Month	Control	PS-MP 1mg/dl	PS-MP 3mg/dl	
Count (x 10^6/mL)	13.68±5.54	7.52±4.54 **	8.52±2.62 **	0.128
Abnormality rate (%)	5.90±1.244	13.90±9.67 **	13.90±3.11 **	0.144
Motility rate (%)	19.36±4.69	12.48±7.28 **	15.06±12.40 **	0.482

Abnormal sperms included sperms of double tail deformity, sperms of double head deformity, sperms of folded body deformity, sperms of folded neck deformity and sperms of unstable head deformity.

*One way anova analysis. **$p < 0.05$ as compared with Control.

Conclusions

This study demonstrated that PS-MPs induced male reproductive dysfunctions in mice, which provided new insights into the toxicity of MPs in mammals.

References

1. Hartmann NB, Hüffer T, Thompson RC, Hassellöv M, Verschoor A, Daugaard AE, et al. Are We Speaking the Same Language? Recommendations for a Definition and Categorization Framework for Plastic Debris. Environ Sci Technol. 2019;53(3):1039-47.
2. de Souza Machado AA, Kloas W, Zarfl C, Hempel S, Rillig MC. Microplastics as an emerging threat to terrestrial ecosystems. Glob Chang Biol. 2018;24(4):1405-16.
3. Prata JC. Airborne microplastics: Consequences to human health? Environ Pollut. 2018;234:115-26.
4. Kannan K, Vimalkumar K. A Review of Human Exposure to Microplastics and Insights Into Microplastics as Obesogens. Front Endocrinol (Lausanne). 2021;12:724989.
5. Mitrano DM, Wick P, Nowack B. Placing nanoplastics in the context of global plastic pollution. Nat Nanotechnol. 2021;16(5):491-500.
6. Wright SL, Kelly FJ. Plastic and Human Health: A Micro Issue? Environ Sci Technol. 2017;51(12):6634-47.
7. Lu K, Zhan D, Fang Y, Li L, Chen G, Chen S, et al. Microplastics, potential threat to patients with lung diseases. Front Toxicol. 2022;4:958414.
8. Okamura T, Hamaguchi M, Hasegawa Y, Hashimoto Y, Majima S, Senmaru T, et al. Oral Exposure to Polystyrene Microplastics of Mice on a Normal or High-Fat Diet and Intestinal and Metabolic Outcomes. Environ Health Perspect. 2023;131(2):27006.