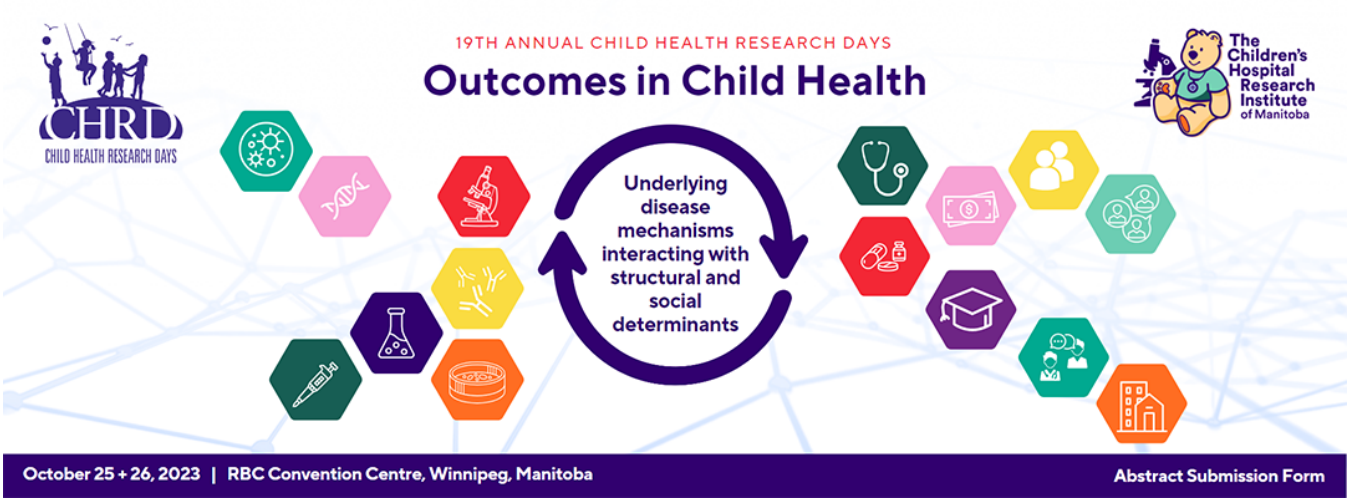

CHRD 2023: Abstract Submission Form

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Presenter Status
Non-Trainee

Research Category
Basic Science

Role in the project
Design
Perform Experiments
Analyze Data
Write Abstract

Title
Development Of A 3D Bioprinted Airway Smooth Muscle Model For Manipulating Structure And Measuring Contraction

Background
The contraction of airway smooth muscle (ASM) is inextricably linked to its mechanical properties and surrounding mechanical environment. Our ability to study pediatric lung disease is hampered by an inability to replicate realistic mechanical contexts for ASM in vitro.

Objective
We used 3D bioprinting technology to generate an experimental model of ASM with a wide scope for modulating tissue mechanics.

Methods
Using a multi-material 3D bioprinter we developed a stiffness-modifiable alginate-collagen-fibrinogen bioink and three tissue designs to interrogate how structure affects ASM contraction; bare ASM rings, ‘sandwiches’ that encapsulate ASM rings within a spring-like structural frame, and ‘spiderwebs’ that further constrain spring structures within a rigid holder. Lumen area was tracked by videomicroscopy, and actin filaments stained with phalloidin.

Results
Stiffness modulation of bare rings was unfeasible; bioinks favorable for muscle formation led to structural failure. Sandwich and spiderweb designs with soft muscle and stiff structural components were physically

stable during culture. Lumen area compacted by <25% (day 5) indicating baseline tone development, and ASM developed realistic actin filament organisation. ASM contracted appropriately to acetylcholine and KCl, and relaxed to cytochalasin D. Importantly, these responses were modulated by stiffness. The compliant sandwich design allowed larger contraction magnitudes (KCl, 10% area reduction) and incomplete relaxation to cytochalasin D. In contrast, the stiffer spiderweb limited contraction (KCl, <5% area reduction) and endured repeated maximal contractions. Sudden removal of the structural component by depolymerizing alginate with citrate/EDTA further revealed contrasting dynamics; sandwiches collapsed slowly (<50% area reduction, 5 minutes), while spiderwebs collapsed rapidly and extensively (>50% area reduction, 2 minutes).

Conclusion
Our 3D bioprinted ASM represents a new paradigm for studying ASM contraction in realistic mechanical contexts. This experimental model will allow us to study how altered mechanical environments, extracellular matrix composition, and fibrosis contribute to pediatric lung disease

Table/Figure File
CHRD abstract 2023.pdf

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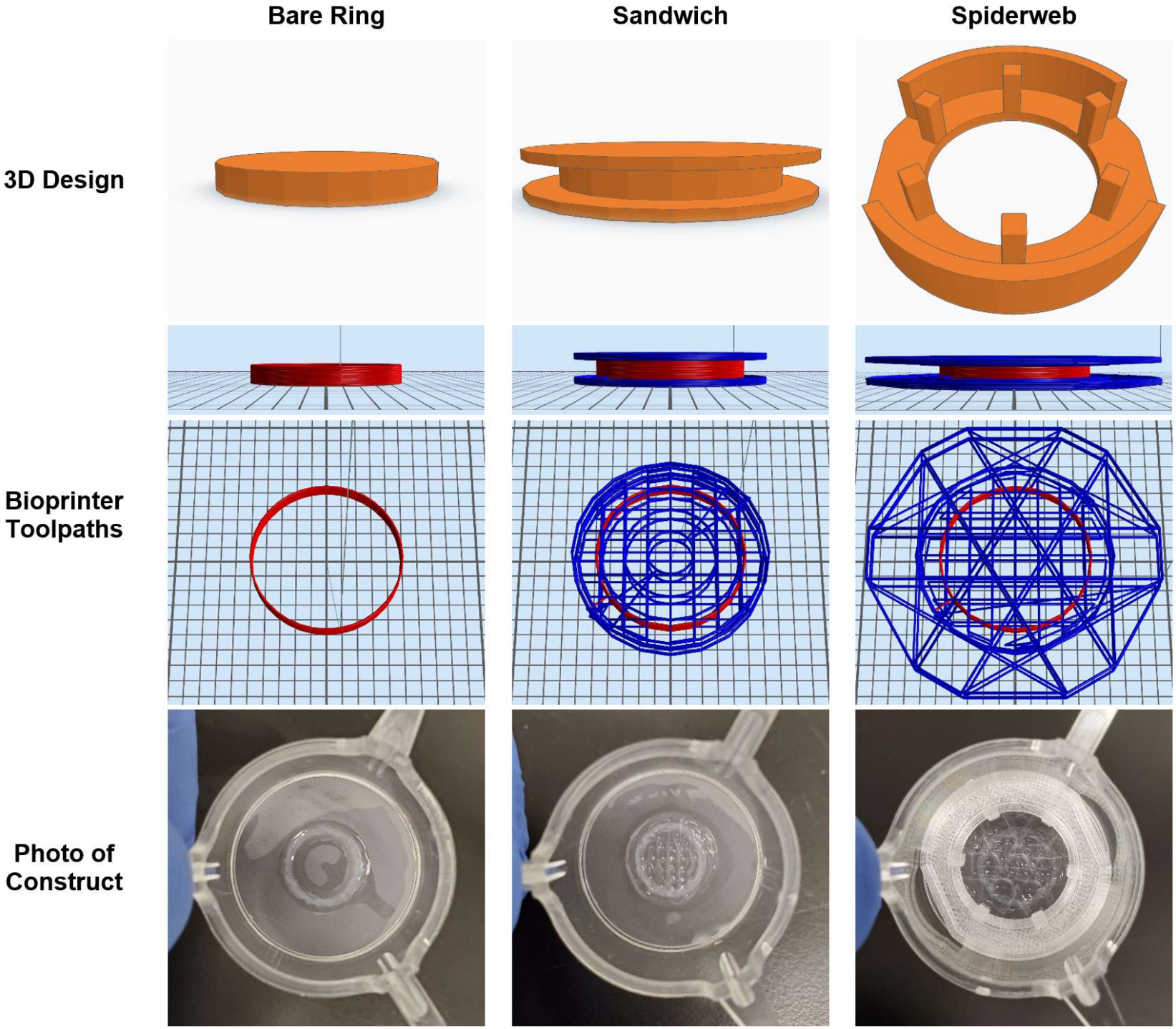
Bare Ring
Sandwich
Spiderweb
3D Design
Bioprinter Toolpaths
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