

# Weaving Challenges into Sustainable Uniforms

## Problem statement

High consumption of uniforms containing polyester at National Cancer Centre Singapore contributes to landfill waste and microplastic pollution, posing challenges for waste management and sustainability efforts



# EXECUTIVE SUMMARY



## 1. Situation

Annually, 98,000 healthcare workers use 294,000 polyester-viscose uniforms, consuming 57,800m<sup>3</sup> of water, emitting 2,530 tonnes of CO<sub>2</sub>, and adding to 20% of global water pollution from textile manufacturing.



## 2. Challenges

Uniforms ending up in landfills, tiny plastic fibers polluting the environment, and harmful chemicals from textile treatments - these issues impact environmental and human health, raising concerns about sustainability in healthcare.



## 3. Proposed Solution

Transition to 100% rPET (recycled polyethylene terephthalate) uniforms,  
Implement uniform repurposing program,  
Launch opt-in/opt-out system to optimize distribution, and  
Develop educational campaign on sustainable practices.



## 4. Expected Benefits

Reduction in carbon footprint, water and energy usage,  
Decrease in landfill waste from uniforms, reduction in microplastic release,  
Lower uniform consumption through optimized distribution,  
Extended uniform lifespan through repurposing - Potential cost savings,  
Support for social enterprises through repurposing program.

**98,000**

**Clinical and patient-facing manpower**

**294,000**

**Healthcare uniforms**



# POLYESTER + VISCOSE

**18,380** m<sup>3</sup>

Of water used

**805** tonnes

of CO<sub>2</sub> released

**21,816** MJ

of energy used

Medical textile types:

## 1. Healthcare And Hygiene Products

*e.g. bedding, clothing, surgical gowns, wipes, and other disposable products.*

## 2. Extracorporeal Devices

*e.g. artificial organs such as kidney, liver, lungs, or pacemakers.*

## 3. Implantable Materials

*e.g. sutures, vascular grafts, scaffolds.*

## 4. Non-implantable Materials

*e.g. wound dressings, bandages, plasters, pressure garments.*

## 5. Intelligent Medical And Healthcare Textiles

## 6. Textiles In Healthcare Environments

*e.g. furnishing fabrics, textiles in fixtures and fittings.*

## 7. Environmental Hygiene Control Components

*e.g. air filters.*





FIBRE  
PRODUCTION

TEXTILE  
PRODUCTION  
AND CLOTHING  
MANUFACTURING

CO<sub>2</sub>

EXPLOITATION OF  
NON-RENEWABLE RESOURCES,  
CHEMICAL, ENERGY, WATER  
USAGE, EMISSION TO AIR



**20% of global water  
pollution is caused by  
dyeing and finishing  
textile products**





FIBRE  
PRODUCTION

TEXTILE  
PRODUCTION  
AND CLOTHING  
MANUFACTURING

USE

DISPOSAL

CO<sub>2</sub>

EXPLOITATION OF  
NON-RENEWABLE RESOURCES,  
CHEMICAL, ENERGY, WATER  
USAGE, EMISSION TO AIR

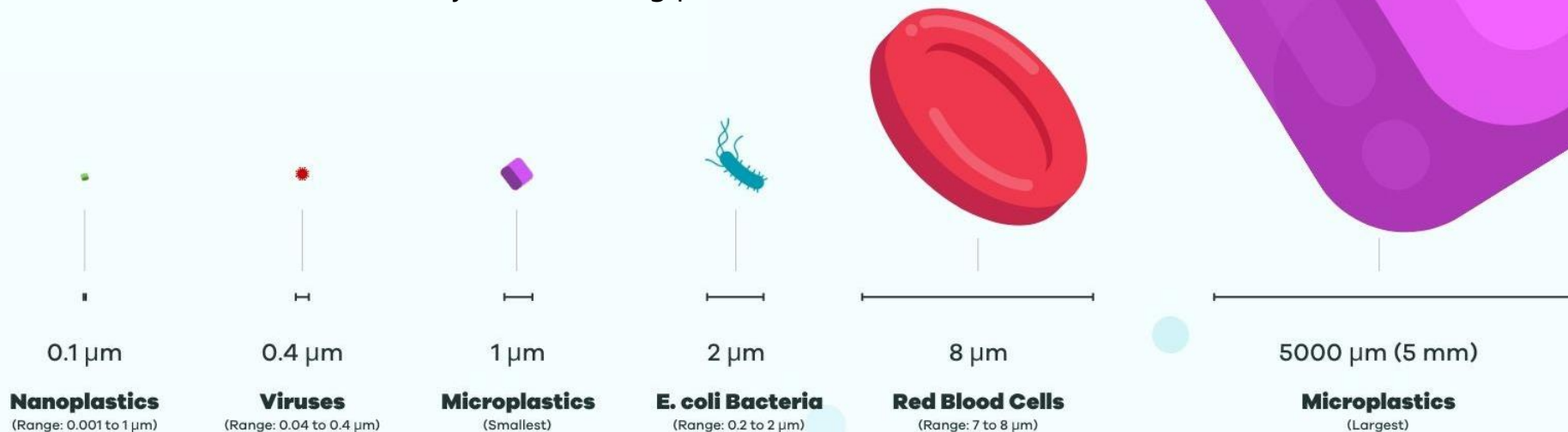
SOIL, WATER, AND  
AIR POLLUTION





# Microplastics

Approximately half a million tonnes of plastic microfibres are released into the ocean annually from washing plastic-based textiles



# 65%

of microplastics may be emitted to aerial environments during the drying and wearing of garments pollutes

TRANSPORT BY WIND, RUNOFF, RIVERS,  
WASTEWATER, ICE AND OCEAN CURRENTS

Sea-based sources

Land-based sources

- Discarded fishing gear
- Pellet losses
- Marine coatings
- Marine litter

- Litter
- Personal care products
- Wearing and washing of clothing
- Coatings
- Turfs
- Automotive tyres and brakes
- Road markings
- City dust
- Pellet losses
- Sewage sludge as fertiliser

SINKS: SOIL, SEDIMENT, COASTLINE, OCEAN WATER, WATER ORGANISMS, FRESHWATER, ICE AND SNOW

# Human Health Impacts of Exposure to Chemicals in Microplastics

## Neurodevelopmental disorders

Attention deficit hyperactivity disorder (ADHD)  
Autism  
Neurobehavioral deficits  
Decreased IQ  
Cognitive deficits

## Hormonal diseases

Thyroid disease  
Thyroid cancer

## Cardiovascular disease

## Respiratory diseases

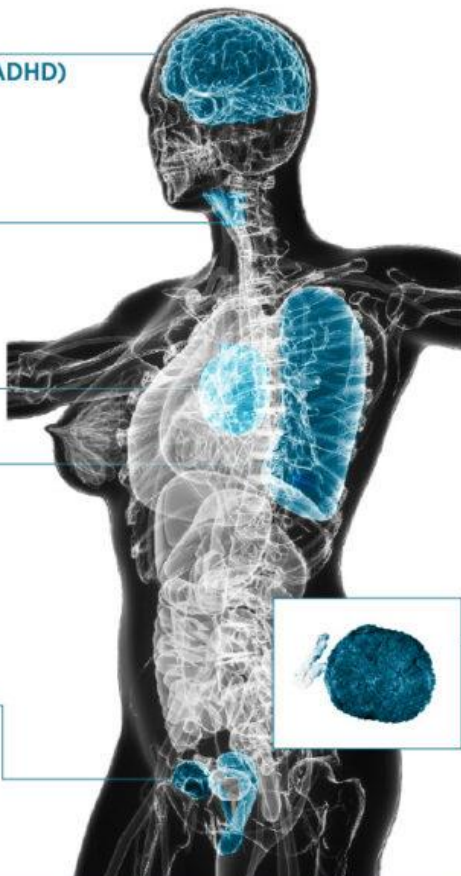
Asthma

## Male reproductive health impacts

Subfertility  
Reduced sperm quality

## Female reproductive health impacts

Polycystic ovarian syndrome  
Endometriosis  
Delayed time to pregnancy  
Abnormal Pap smears  
Pregnancy-induced hypertension and/or preeclampsia



## Metabolic disorders

Type 2 diabetes  
Excessive childhood weight gain  
Increased waist circumference  
Serum lipid levels,  
e.g., total cholesterol  
and LDL cholesterol

## Other health impacts

Decreased antibody  
response to vaccines  
Physical damage  
Carcinogen absorption

## Pregnancy outcomes

Preterm birth  
Lower birth weight  
Abnormal genital structure  
(anogenital distance)  
Altered pubertal timing

# OUR PROPOSAL

# Repurpose used uniforms

THE CIRCULAR CLASSROOM

x



EMPOWERING LIVES.  
UPLIFTING COMMUNITIES.



THE CIRCULAR CLASSROOM  
Creating Net-Zero Classrooms

Circularity in education and repurpose uniforms for social and environmental good.

Sustainability Projects in Schools

Trainings workshops

Studies and Research on Environmental Education


Creation of Uniforms 2.0



# Educational poster

How to reduce  
microfibre pollution?

**GROUND**  
Greening Our Singapore 4p-4ki Green

 National Cancer  
Centre Singapore

## 6 TIPS YOU NEED TO KNOW



**Wash at 30°C or lower in shorter cycle**

Studies have shown that switching to colder and shorter cycle can drastically reduce microfibre shedding



**Use front load washing machine**

Top load washing machine tend to produce more microfibres than front load washing machine



**Wash at full load**

This results in less friction between clothes and reduce of microfibres. The best option is to load the drum 3/4 full



**Use sustainable detergent**

Conventional detergent can contain harmful ingredients to the environment



**Use microfibre-catching devices**

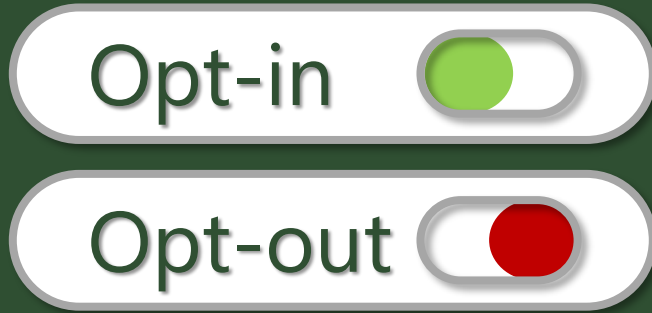
Lint filters or washing bags that are commercially available can help trap microfibres



**Air dry instead of tumble dry**

Air drying your clothes not only prolong their lifespan but it also reduces the emission of microfibres into the air

# Reduce consumption



If each staff takes 1 less set of uniform,

 **33%**

**Carbon footprint, water and energy use, environmental and health harms**

# Sustainable Uniform





# 100% rPET



# ECONOMIC AND STRATEGIC BENEFITS

## Economic Annual Savings of **\$540k**

- Water cost saving: S\$36,260.06
- Energy cost saving: S\$955.83
- Carbon tax saving: S\$12,477.50
- Uniform replacement cost saving: S\$490,000

## Strategic and Non Economic Benefits

- Water usage reduction: 13,233.6 m<sup>3</sup>
- Energy consumption reduction: 3,757.2 kWh
- CO<sub>2</sub> emissions reduction: 499.1 tonnes
- Waste reduction: 24,500 uniforms/year  
3.9 million 1.5L PET bottles/year
- Microplastic release reduction:  
20% (Est – substantiated via pilot test data)
- Improved sustainability profile for NCCS
- Potential positive impact on staff satisfaction and public perception
- Supports Singapore's Zero Waste Masterplan
- Extend the Semakau Landfill lifespan

# Triple Bottomline



**Uniform lifespan**



**Consumption**



**Cost**



**Carbon footprint, water and energy usage,  
landfill waste and microplastic pollution**



**Health harms**



**Support local communities**



# THE WAY FORWARD



## Key Challenge

294,000 polyester-viscose uniforms consumed annually has high environmental impact on water, CO<sub>2</sub>, and energy, and releases harmful chemicals and microplastics, polluting global waters and atmosphere.



## Sustainable Solution

Transition to 100% rPET uniforms, implement repurposing program, optimize distribution, and launch sustainability education campaign.



## Expected Outcomes

Decreased environmental footprint, reduced landfill waste, extended uniform lifespan, potential cost savings, and enhanced sustainability profile.



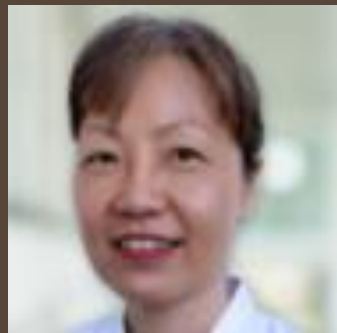
## Path Forward

Conduct pilot program, perform detailed cost-benefit analysis, engage suppliers, and develop impact metrics to guide full-scale implementation.

# OUR TEAM



**Audrey Koh**  
Senior Executive, NCCS (DSPC)



**Tay Beng Choo**  
Senior Nurse Clinician, NCCS (DSPC)



**Michelle Sim**  
Medical Social Worker, NCCS (DPO)



**Adele Woon**  
Nurse Clinician, NCCS (Nursing)



**Celinn Tan**  
Assistant Manager, NCCS (Operations Support  
Services)



**Joanne Ngeow**  
Senior Consultant, NCCS (DMO)

# Thank you

Centre of Healthcare Innovation (CHI)

SIT Coaches

Management of NCCS

ALPS

The Circular Classroom

Dragon Uniform Pte Ltd

# REFERENCE

1. Healthcare Without Harm. The role of chemistry in sustainable medical textiles. Updated December 8, 2021. Available from: <https://noharm-europe.org/sites/default/files/documents-files/6970/2021-12-08-updated-The-role-of-chemistry-in-sustainable-medical-textiles.pdf>. Accessed July 4, 2024.
2. European Environment Agency. Microplastics from textiles: Towards a circular economy for synthetic textiles in Europe. Available from: <https://www.eea.europa.eu/publications/microplastics-from-textiles-towards-a>. Accessed July 4, 2024.
3. Ministry of Health, Singapore. Effectiveness of efforts to attract more Singaporeans to join healthcare industry. Available from: <https://www.moh.gov.sg/news-highlights/details/effectiveness-of-efforts-to-attract-more-singaporeans-to-join-healthcare-industry>. Accessed July 4, 2024.
4. Daukantienė V. Analysis of the sustainability aspects of fashion: A literature review. *Textile Research Journal*. 2023;93(3-4):991-1002. doi:10.1177/00405175221124971.
5. Chen J, Wu J, Sherrell PC, Chen J, Wang H, Zhang WX, Yang J. How to Build a Microplastics-Free Environment: Strategies for Microplastics Degradation and Plastics Recycling. *Adv Sci (Weinh)*. 2022 Feb;9(6). doi: 10.1002/advs.202103764. Epub 2022 Jan 6. PMID: 34989178; PMCID: PMC8867153.
6. Gaylarde C, Baptista-Neto JA, da Fonseca EM. Plastic microfibre pollution: how important is clothes' laundering? *Heliyon*. 2021 May 25;7(5). doi: 10.1016/j.heliyon.2021.e07105. PMID: 34095591; PMCID: PMC8167216.
7. Kärkkäinen N, Sillanpää M. Quantification of different microplastic fibres discharged from textiles in machine wash and tumble drying. *Environ Sci Pollut Res Int*. 2021 Apr;28(13):16253-16263. doi: 10.1007/s11356-020-11988-2. Epub 2020 Dec 18. PMID: 33340055; PMCID: PMC7969573.
8. Akyildiz SH, Fiore S, Bruno M, Sezgin H, Yalcin-Enis I, Yalcin B, Bellopede R. Release of microplastic fibers from synthetic textiles during household washing. *Environmental Pollution*. 2024;357:124455. doi: 10.1016/j.envpol.2024.124455.
9. Palacios-Mateo C, van der Meer Y, Seide G. Analysis of the polyester clothing value chain to identify key intervention points for sustainability. *Environ Sci Eur*. 2021;33(1):2. doi: 10.1186/s12302-020-00447-x. Epub 2021 Jan 6. PMID: 33432280; PMCID: PMC7787125.
10. Periyasamy AP, Tehrani-Bagha A. A review on microplastic emission from textile materials and its reduction techniques. *Polymer Degradation and Stability*. 2022;199:109901. doi: 10.1016/j.polydegradstab.2022.109901..

# REFERENCE

11. Šaravanja A, Pušić T, Dekanić T. Microplastics in Wastewater by Washing Polyester Fabrics. *Materials* (Basel). 2022 Apr 6;15(7):2683. doi: 10.3390/ma15072683. PMID: 35408015; PMCID: PMC9000408.
12. Tap Score. Are Microplastics in My Drinking Water? Tap Score. Available at: <https://mytapscore.com/blogs/tips-for-taps/are-microplastics-in-my-drinking-water>. Accessed July 4, 2024.
13. Center for International Environmental Law (CIEL). Breathing Plastic: The Health Impacts of Invisible Plastics in the Air. Center for International Environmental Law (CIEL). Available at: <https://www.ciel.org/breathing-plastic-the-health-impacts-of-invisible-plastics-in-the-air/>. Accessed July 4, 2024.