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Exploring the material experience of fungal textiles in orthopaedic garments

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ABSTRACT

Orthopaedic garments improve the quality of life for individuals with chronic conditions, injuries, or in search of preventative support. This study explores the potential application of fungal textile materials to orthopaedic garments for the hand and wrist areas, focusing on identifying key experiential qualities for seven participants. Iterative exploration in creating fungal materials with differential flexibility and cushioning resulted in three distinct material samples, four textural patterns, and three concepts, each showcasing the varied qualities. These outcomes were assessed through semi-structured qualitative interviews, focusing on qualities of fungal textile and user perceptions of their comfort, relevance, and desirability. Participants valued the materials' natural qualities and potential for varying combinations to suit breathability and temporal needs in their unique use cases, informing further prototyping. By harnessing the unique qualities of fungal textiles, this research proposes how these materials can meet diverse wellness needs while reducing reliance on synthetic and non-renewable materials.

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Fungal textiles, orthopaedic garments, assistive wearables, user study, user experience, materials experience, textile experience

1. Introduction

Orthopaedic garments are essential for improving the quality of life for individuals with chronic conditions, injuries, or those seeking preventative support—particularly in the hand and wrist, one of the most complex body areas critical for performing daily tasks (Nasir, Troynikov, and Massy-Westropp 2014). Conventional materials used in these garments, namely synthetic fibers and rigid composites, often present challenges, including poor breathability, limited adaptability, social stigma around their design, and environmental concerns. These limitations can hinder user comfort, adherence, and the

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overall sustainability of the garments. Moreover, many of these garments are temporary solutions, creating a mismatch between their short lifecycle and the lasting environmental impact of their materials.

Fungal textiles can offer an innovative and sustainable alternative for orthopaedic garments, providing benefits including customizable support, insulation, aesthetic connotations, potential therapeutic properties (Manan et al. 2021), and unique sensory experiences associated with comfort. Their renewability and compostability make them well-suited for orthopaedic garments, as their lifespans match the garment's often temporary functional duration. Among different available techniques, we focused on fungal textiles derived from the pulp of fruiting bodies (Nakauchi, Amano, and Tagawa 2023) and mycelium grown in liquid media (Elsacker, Vandelook, et al. 2023), resulting in textile-like materials with differential flexibility and support (Fang, Parisi, and Karana 2026).

This study investigates user perceptions associated with fungal-based materials to understand their potential as sustainable alternatives for textiles in supportive garments. Through creating and assessing participant experiences of various material samples, textural patterns, and concept forms, we seek to identify the key factors that influence comfort, usability and overall feasibility of integrating fungal textiles into assistive garments.

2. Background

2.1. Orthopaedic garments – an overview

Orthopaedic garments provide essential support, compression, and stability for individuals with musculoskeletal diseases, those with injuries, and athletes. These garments encompass compressive gloves or sleeves, wraps (bandage or gloves), splints (resting or working), braces and other custom designs tailored for therapeutic or assistive purposes (Mikucioniene et al. 2024; Nasir, Troynikov, and Massy-Westropp 2014; Vaishya et al. 2018). Their functions include reducing swelling for people with rheumatoid arthritis (Egan et al. 2001), heat insulation for people with Raynaud's syndrome (Liem et al. 2023), providing support for wrist injuries or carpal tunnel, or improving athletic performance (Ghai et al. 2024).

For the hand and wrist, compressive gloves and sleeves are used for therapeutic purposes over general areas. Bandage or glove wraps offer a more adaptable option, allowing users to adjust compression levels based on their needs. Splints and braces provide more targeted support, such as immobilizing specific fingers or providing stiffer localized support around weaker joints. They range in terms of rigidity, which is often determined by their material composition but can also be simulated through compression (Mikučionienė and Milašiūtė 2017). Similarly, compressive glove forms can create targeted

support such as in the volar (palm) area through insertion of padding (Trevithick, Mellifont, and Sayers 2020) and other material combinations, higher compression targeting the commonly inflamed interphalangeal (ICP) and metacarpophalangeal (MCP) joints in rheumatoid arthritis (Barbarioli 2001), or lamination of layered materials for additional stiffness (Goncu-Berk and Topcuoglu 2017). Advanced technologies, like 3D scanning to generate compression textiles for chronic venous disease (Shi, Liu, and Ye 2024) and variable property fabrication of gloves for carpal tunnel syndrome (Oxman 2010), enable precise mapping to pain points for more targeted pressure.

Despite advancements in orthopaedic garments, significant gaps persist in addressing users' nuanced needs. These include changing temporal needs with swelling differing in the span of months, weeks or even days, obtrusiveness during daily wear, and negative effects caused by improper fit (Fang 2020). Critical disability studies and inclusive design principles emphasize the importance of involving users in the design process (Pullin 2009) and addressing broader contextual barriers over perceived individual problems. Cook and Polgar (2013) similarly outline the importance of considerations of such social and cultural environments. Perceived conflict with social norms also leads to lack of user adoption or adherence which hinders their treatment (Edwards 2003). While research in this area underscores the value of individualization, social perception, desirability, and comfort, current materials and methods often fall short of achieving these qualities in unison.

2.2. Materials in orthopaedic garments

Orthopaedic garments rely on a range of materials to provide different support and compressive properties. Splints and braces have been made with carbon-fiber composites, thermoplastics, leather (Thiele et al. 2009), and earlier in history employing wood and metal. These structures often use rigid or semi-rigid materials, which are supplemented by softer padding in the form of foams or gels for comfort and elastic materials for fit. Compressive garments and wraps use a variety of synthetic elastic materials, typically created by combining multiple yarns where one provides structural stiffness and the other elasticity (Mikučionienė and Milašiūtė 2017). Common synthetic elastic materials include spandex, nylon, lycra or neoprene which can be engineered to offer varying levels of compression and flexibility. These materials often pose barriers with breathability, skin irritation (Pereira et al. 2007), interfacing between different materials (Mikucioniene et al. 2024), and sustainability challenges.

Recent advancements have explored adaptive metamaterials or eco-friendly materials to address those challenges. Cheng et al. (2020, 2021) utilized ABS and hygroscopic wood-polymer composite filaments to develop 4D-printed orthotic splints with adaptive shape-changing regions for pressure relief, strategic

distribution of hard and soft areas, and bio-inspired moisture-activated tightening mechanisms. Efforts to explore materials like bamboo and hemp (Halavska and Batrak 2016) have also been initiated for more sustainable alternatives.

2.3. The art and science of fungal textiles

Fungal textiles are flexible, textile-like materials derived from fungi through diverse processes. One method involves harvesting material from the trama (inner layer) of the fruiting bodies of hoof fungi, a traditional craft technique (Gandia et al. 2021) still found in Romania that produces the suede-like material 'amadou'. A variation of this involves the creation of mycelium pulp from fruiting bodies (Nakauchi, Amano, and Tagawa 2023). A second method involves liquid-state fermentation of pure mycelium into flexible mycelial hides (Adamatzky, Gandia, and Chiolerio 2021). A third method involves harvesting the aerial mycelium from the surface of composite structures to create leather alternatives (Elsacker, Vandelook, et al. 2023). Fungal textiles can exhibit varying properties based on post-processing methods applied, including plasticization (using glycerol), deacetylation, tanning, heat treatment, cross linking (Jones et al. 2020), and coatings with oil or films (Elsacker et al. 2020). These techniques allow for adjustments in stiffness, flexibility, durability, color, or hydrophobicity to meet specific material requirements. For instance, altering glycerol percentage can transform material properties from brittle to natural or elastomeric (Appels et al. 2020).

Such versatility has supported applications to fitness accessories (e.g. Fraxinea's Symbiomat), and fashion items by companies (e.g. SQIM) and designers (e.g. Mycotex by NEFFA). Fungal textiles have been adopted as sustainable leather alternatives by major luxury brands (Amobonye et al. 2023), garnering attention for properties, including biodegradability, insulation, and aesthetics.

Fungal textiles can be engineered to be formed into custom shapes with differential patterning and properties for specific areas of flexibility or cushioning, making them a compelling option for assistive wearable applications (Fang, Parisi, and Karana 2026). In this previous study, we explored conformal fabrication techniques of fungal textiles, combining freeze-drying and heat-pressing to create mono-material textiles with localized malleability and cushioning properties. However, the application of fungal textiles to orthopaedic garments remains underexplored. This work contributes to the emerging use of biomaterials in wearable design by proposing fungal materials as an adaptable material for assistive garments.

3. Methodology

To explore the user experience of fungal textiles in orthopaedic garments, we conducted seven qualitative semi-structured interviews ranging from 45 to

60 min using the outline in [Online Appendix 3](#). In novel applications for personal and assistive technologies, interviews have been useful for involving user preferences, perceptions, and challenges related to comfort, adjustability, and material performance (Boser et al. 2021; Goncu-Berk and Topcuoglu 2017). In our study, the Materials Experience framework (Giaccardi and Karana 2015; Karana 2009), informed interview questions development ([Online Appendix 4](#)) and the subsequent analysis. This approach has been widely used to understand material experiences with novel biomaterials, including mycelium-based composites (Karana et al. 2018; Parisi, Rognoli, and Ayala-Garcia 2016; Van Den Broek, Rovers, and Calcan 2024). While perceptions of other bio-fabricated textiles, like bacterial cellulose, have been investigated (Papile et al. 2023), those of fungal textiles remain unexplored.

3.1. Study materials and tools

Three material samples were developed following the processes illustrated in [Online Appendix 1](#) and [2](#) (see, Fang, Parisi, and Karana 2026, for a detailed explanation of the material exploration) using two different approaches: fragmented fruiting bodies from white button and bracket fungi ([Figure 1.1](#) and [1.2](#)), and grown mycelium in liquid media from *Schizophyllum commune* ([Figure 1.3](#)). Samples were freeze-dried, a process that removes moisture while preserving thickness and minimizing collapse, resulting in a raised, foam-like quality; they were then heat-pressed to flatten evenly. Samples were selected based on the ability to provide stiffness, padding, and elastic support. Samples were created to be approximately 6 cm in diameter for ease of participant handling. Material 1 was chosen to create the remainder of the study artifacts (patterns and concepts) due to its ease of prototyping.



Figure 1. Three material samples. From left to right: 1.1 using fruiting bodies of white button mushrooms; 1.2 using fruiting bodies of bracket fungi; 1.3 from *S. commune* grown mycelium.

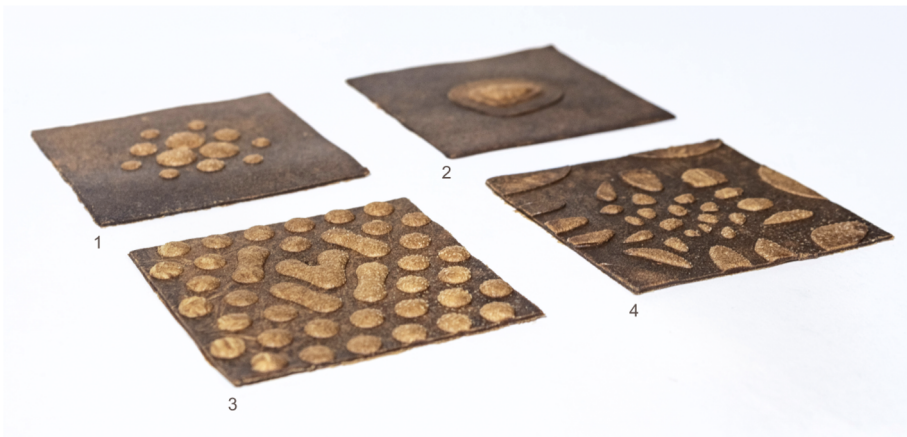


Figure 2. Four pattern samples. 2.1: Cluster; 2.2: Topography; 2.3 Merge; 2.4 Voronoi.



Figure 3. Three concept forms. 3.1: Wrist wrap; 3.2: Ulnar deviation wrap; 3.3 Thumb and wrist wrap.

Four pattern textures (Figure 2) inspired by ergonomic textures (e.g. Vivobarefoot's Vivobiome) were developed to span a wide range of dimensions (Table 1) to provide differential support with stiffer areas in the center and more diffuse flexibility on the sides. The pattern textures were obtained by heat-pressing the samples using specifically designed pressing molds. The unpressed areas remained padded and foam-like, while the pressed areas became more leather-like. Samples were made approximately 6.5cm across to accommodate pattern size and variability and for ease of participant handling.

Table 1. Parameters used to develop patterns.

Pattern name	Dimensions				
	Base unit shape (Regular, Irregular)	Gradient (localized, global)	Change in size (XY, Z)	Concentric	Linked
1. Cluster	Shape (Regular)	Gradient (Localized)	XY	No	No
2. Topography	Shape (Irregular)	Gradient (Localized)	XY, Z	Yes	No
3. Merge	Shape (Regular)	Gradient (Global)	None	No	Yes
4. Voronoi	Shape (Irregular)	Gradient (Global)	XY, Z	No	No

Three concept forms were developed based on commonly available types of orthopaedic garments (Figure 3). The first was a replacement for the standard wrist wrap available for general use (Figure 3.1). The second was an ulnar deviation wrap, specifically designed for those experiencing joint deformation and drift in rheumatoid arthritis (Figure 3.2). The third was a hybrid new design focusing on both the thumb and wrist joints (Figure 3.3). The concepts were selected to reflect different areas of support for various ICP and MCP joints (Barbarioli 2001), levels of coverage, and a range of use cases from general to specialized. Samples were modelled for a small adult hand for ease of participant handling.

3.2. Participants

Seven participants (three male and four female) with diverse orthopaedic garment experiences and use cases were enrolled in the study. Participants were recruited *via* public posters, email, and word-of-mouth outreach, and screened based on existing experience with orthopaedic garments.

3.3. Procedure

After an introduction to the interview session, participants were asked about their prior and current experiences with orthopaedic garments, which they were invited to bring along (Figure 4). Then they assessed the three material samples (Figure 5). Next, they reacted to the four patterns and ranked them based on their perceived comfort and relevance (Figure 6). Finally, three concepts were presented (Figure 7) to prompt feedback on potential use cases and assess potential desirability and utility of the designs. Throughout the session, participants interacted with all artefacts. The study was designed and conducted in compliance with TU Delft, Human Research Ethics approval (n. 3877), and all participants provided informed consent. See Appendices 3 and 4 for the interview structure and questions.

3.4. Data collection and analysis

Interviews were conducted by the first author, with audio-only recordings capturing participants' responses during the first portion focused on previous experiences, followed by video recordings documenting only audio and hand



Figure 4. Participant describing their previous orthopaedic garment usage.



Figure 5. Participant interactions with material samples.

interactions with the artefacts. Hand-only interactions were also photographed by the first author. Subsequently, interviews were transcribed and the data analyzed and synthesized using affinity mapping (Iba, Yoshikawa, and Munakata 2017) and grounded theory techniques (Glaser and Strauss 1973).

4. Results

The results from the user studies highlighted general user needs around orthopaedic garments, participant experience with the three material samples, four textural patterns, and feedback for the three concept forms.

4.1. Experiences with orthopaedic garments

Participants distinguished between garments for prevention and those for healing. P3 had garments on the 'elbow [which was] more maintenance, wrist

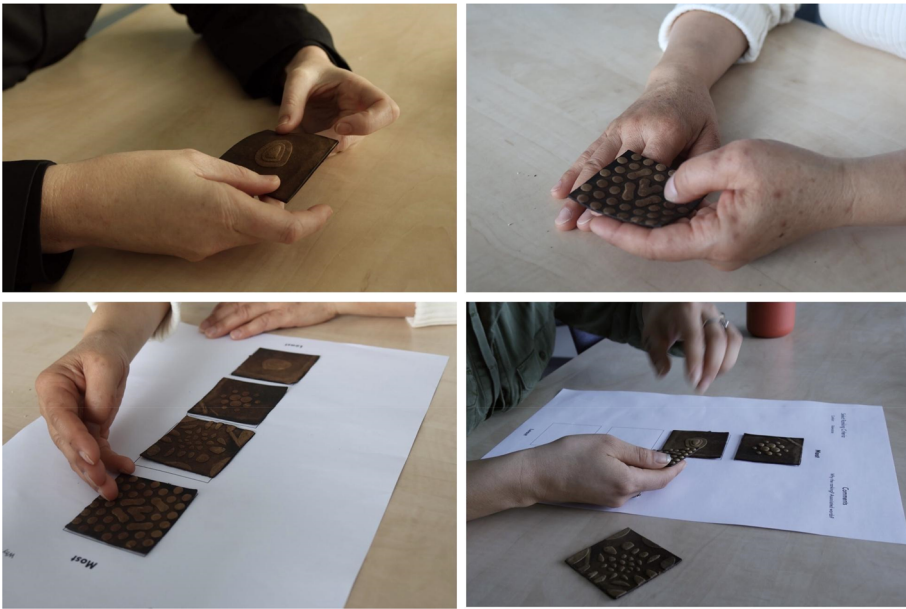


Figure 6. Participant interactions with patterns and forced ranking.



Figure 7. Participant interactions with the three concepts.

more for injury’, and P7 wore theirs to ‘keep the swelling down’. Some wearables were used for everyday exercise, while others were worn only when pain was felt. P5 used a knee compression sleeve which was ‘most useful when [they had] a lot of floorwork to do in dance’. P1 noted they ‘would use [their garment] until I wasn’t really in pain anymore, and then when the pain flared back up’. Some existing wearables incorporate a combination of multiple materials, including silicone and an elastic fiber, to provide varying levels of stiffness and flexibility.

Adjustability was an appreciated feature, with wrist wraps being particularly favored. P4 remarked that their wrist wrap was ‘like wearing gloves, but easier to wear and thinner’ and P5 liked that they ‘could loosen it throughout the day’ as needed. Brace-like wearables, while disliked for their restrictiveness, were acknowledged as necessary for their intended purpose of limiting movement. P6 said it was ‘like putting hands on a concrete surface, not really

convenient or comfortable but you have to do it'. P3 noted it's 'uncomfortable because it's restrictive, which is the point'. The importance of conformability throughout all garment types was remarked upon with P7 having a splint that 'used material they warmed up and shaped according to my hand'. P5's knee compression sleeve 'didn't mold to the knee, a very mobile joint, so it slipped or cut off blood circulation and made the problem worse'.

Breathability, including humidity, odor, and sweat concerns, was frequently mentioned with linked issues of cleanliness. P2 noted 'after a while it gets really disgusting' and P7 had 'lots of moisture capture [which made their] skin all wet [and] turned white'. Participants noted that some wearables provoked skin issues while solving joint issues, as irritation provoked by rubbing could occur with prolonged use. P1 felt like 'sometimes the metal rod would rub against my ankle and create other problems'. The aesthetic connotations of the garments were also brought up with P3 saying it 'makes it look like I've got something wrong with me, people comment on it'.

See [Appendix 5](#) for an overview of participant characteristics, wearable experiences, and themes.

4.2. Materials

4.2.1. Material 1: White button fruiting bodies

Participants described Material 1 as leather-like, natural, and skin-like, appreciating its organic color and edges, soft texture, and smell. These evoked positive associations and a handmade feel, as P2 noted, 'the imperfections. make it feel not mass manufactured'. Participants mentioned that, 'aesthetically, this feels very groovy, and something that I'd want to wear' (P1) and 'it reminds me of a luxury garment' (P6). However, many participants were apprehensive about its breathability, drawing parallels to leather and questioning its ability to manage sweat or humidity. Another drawback was the sticky sensation the fungal material left upon touch. Additionally, the material's perceived fragility was a concern, with participants doubting its capacity to endure movement or bending around smaller curves. 'In areas of a lot of mobility it would end up tearing or rubbing against itself'(P5).

4.2.2. Material 2: Bracket fungi fruiting bodies

Material 2 was described as soft, spongy, and squishy, with participants regarding it as more robust compared to Material 1 due to its thickness. This led many to suggest it could serve as a cushioning or protective inner layer, with P7 noting, it could 'absorb some moisture' and 'the temperature doesn't go up quickly with your hand'; and P5 remarking it was 'more breathable'. However, concerns were raised about its durability, with some participants noting that it might flake or come off during use. Its organic appearance drew associations with food, like tortillas, as well as conventional materials

like velvet, suede, and felt. These associations evoked warm and positive feelings that denoted its appeal. It 'feels like a caring thing' and 'overall makes you really relaxed' (P6).

4.2.3. Material 3: Grown mycelium from *S. commune*

This material had a rubbery texture with a slight bounce, surprising many participants with its resilience, given its thin and seemingly fragile appearance. P1 remarked, 'Whoa! When I looked at it, I wasn't expecting it to be as malleable as it turns out ... , which is very satisfying', and P3 said it 'feels like it could be stretchy'. Participants associated it with skin-like qualities, likening it to an organic outer layer or breathable membrane. The material's flexibility was a point of interest, as participants noted its ability to curl and roll around smaller curves, making it more versatile than the other materials. The contrast between the top and bottom sides of the material further captured participants' attention, with many drawing upon mushroom imagery to describe its appearance and texture. P6 noted the 'different colors on different sides remind me of double-sided clothing' with it 'seeming more like for outer layers' (P4).

4.3. Patterns

4.3.1. Pattern 1: Cluster

Participants appreciated Pattern 1 for its functional and tactile qualities, noting it could provide specific support and enjoyed the 'fun tactile experience' (P5) of pressing on the material pattern. Many felt that the bumps created gaps between the material and the skin, potentially improving breathability. Participant 3 remarked it had 'cushioning but with airflow' with potential placement 'where it was sweatiest, like palms of hands'. The pattern was seen as versatile, with applications in gripping or healing contexts to 'use for pressure points' (P2). Visually, it evoked associations with technology and science. P5 said it's a 'very traditional like pattern that I'd see on like the non-slip portion of the knee sleeve that I'd wear. So, this just looks normal to me'.

4.3.2. Pattern 2: Topography

Pattern 2 evoked associations with topography, and participants felt it resembled a personalized map of the body. Participant 3 remarked it 'feels engineered for you' and 'mapped between your body'. Participants remarked that the layered design offered a more gradual gradients of support 'between a more flexible to more rigid element' (P3). They suggested this pattern was more suitable for casual use, with P4 saying it was 'more gentle' and P6 'more fashionable than athletic'. Its organic nature was associated with potential mental relaxation, suggesting it could be a calming and supportive feature. P3 highlighted the 'skin-like quality with organic shapes'.

4.3.3. Pattern 3: Merge

Participants perceived Pattern 3 as offering more universal support and looking computational and non-natural. P1 called it ‘generically versus specifically helpful’, and P6 saw it as ‘not really organic’. There were strong associations with footwear and gripping, like ‘stoppers on your socks’ (P2), due to similarities with non-slip or tread patterning. Participants could see its potential applications in athletic gear or for general performance purposes. P6 remarked it was a ‘really interesting feeling not fully covering the skin’ and ‘reminds me of a high-performance product’. Some participants reported being overwhelmed by the dots but that they also gave clear indications of differential support and potentially increased airflow.

4.3.4. Pattern 4: Voronoi

Participants perceived Pattern 4 as aggressive and active with its irregular, small, and sharp shapes. Participants associated the pattern with needling, massage stones, and other firm wellness devices. For some, there was a linkage between that sensation of discomfort and healing. P1 said ‘because of its rigidity, it’s ... the most aggressive and seems like it could do the most’ and ‘you get needling ... it’s very specific, not ... negative needling’. P4 mentioned it ‘would be really useful and better function but won’t say it’ll be comfortable’. For others, the pattern felt less medical—‘a bit more active’ (P2) or ‘contemporary’ (P5). Overall, participants perceived this pattern as functional for applying targeted pressure.

4.4. Concepts

4.4.1. Concept 1: Wrist wrap

Concept 1 elicited mixed responses from participants. On the positive side, they appreciated its large coverage, lightweight design, and normal aesthetic. P6 remarked it ‘covered a big surface so it looks reliable’. The concept also sparked vivid associations, with comparisons to falconry and cyberpunk styles, distancing it from clinical looks.

However, participants questioned whether Material 1 used in prototyping could adequately conform and mold to the skin to provide effective support due to large gaps. P3 said it ‘feels like it needs to be molded more’, while P3 speculated it could ‘warm up on your skin, maybe over time going to mold’. For support during movement, some expressed fears about the material tearing under strain. P6 noted ‘if you need to constantly touch something [during the game] the material will be worn out’. Additionally, drawbacks included potential discomfort caused by skin irritation and the concentration of pressure in the design’s thumb area. P7 thought there was ‘a lot of area wrapped with leather-like material, keep[ing] moisture there, so can’t wear it for a long time’. Similarly, P4

suggested 'especially in the summer ... could use the second material in the thumb area'.

4.4.2. Concept 2: Ulnar deviation wrap

Concept 2 was less familiar to participants, as many lacked experience with its specific use case. This unfamiliarity led to concerns about its potential difficulty in use. Some participants speculated on its hypothetical role in protecting the knuckles, even saying it is 'something ... a ninja would wear' (P6). The concept evoked fashionable associations with martial arts and interlacing digits. Some participants expressed concerns about discomfort, especially for the finger and palm area, as well as breathability and skin irritation. P4 remarked it 'can be uncomfortable in the palm' and questioned 'whether it'd be comfortable to have between the fingers especially with this type of material'.

However, others like P5 felt it 'molds to odd curves and small awkward spaces better'. And P7, who was the only participant familiar with the use case, said it's 'just the area I need the support not the whole hand'. They also 'liked the straps' which meant manufacturers 'can do more general production and let those adjust' because a 'personalized one costs a lot of money'.

4.4.3. Concept 3: Thumb and wrist wrap

Concept 3 was a favorite among participants, praised for its elegant, conforming, and agile design. P3 remarked it's 'more elegant, my favorite' and P5 that it 'molded best to the body'. Its minimal coverage stood out for those concerned about humidity and looking for lightweight solutions. P4 noted because it was 'not covering the bottom half of the palm, so it's probably not sweaty'. However, a few participants felt that the coverage might not be sufficient for medical use cases, with P6 'not sure how supportive [it was] because it only covered a small area'. P5 felt because of that 'you'd lose some ... compression. But ... in terms of sensory issues, isn't a concern'.

Still, participants viewed it as a good fit for lightweight, non-medical applications, suitable for casual or everyday use. P6 suggested it was 'suitable with people with less severe disease or hurt', and P2 described it as a 'more dainty version'. Participants were also intrigued by the thumb attachment mechanism, though they expressed curiosity about its durability and long-term functionality. P7 suggested 'add[ing] foam or something in the back' for additional support.

5. Discussion

This study explored the potential of various fungal textile materials, patterns, and concepts for orthopaedic garments, focusing on user perceptions and



Figure 8. Materials and patterns applied to concepts based on participant insights, speculating on potential use cases.

design implications. Findings highlight several key insights, including material layering, pattern-concept associations, concept-material interactions, and broader implications for design, including the materials' semantic and regenerative potentials.

5.1. Overarching insights and design implications

Participants expressed interest in layering the materials, suggesting Material 2 as a cushioning inner layer and Material 1 or 3 as an outer layer (Figure 8). This modularity could help adapt for temporal changes in users' needs, a direction for future research. Additionally, the distinct reactions to patterns suggested they mattered for specific functional associations of the garments. Both Pattern 3 and Pattern 1 were associated with practical and familiar use cases in athletic or performance gear, with Pattern 1 suggesting more focused support and Pattern 3 for more general and larger areas. Pattern 2, perceived as casual and relaxing, seemed best suited for everyday wellbeing and designs that prioritize comfort and ease of adoption. Instead, Pattern 4

provoked stronger emotional reactions with its aggressive and active aesthetic, suggesting appeal for users seeking more targeted therapies. Participants appreciated materials and patterns that prioritize airflow for issues related to humidity and sweat, though some noted that certain patterns left imprints on the reverse side of the material, occasionally causing the bumps to push outwards.

The concepts highlighted a tradeoff between coverage, support, and breathability. Most participants liked the minimalistic nature of Concept 3 but were worried about its minimal coverage compared to Concept 1, which drew more critical reviews. Conformability and matching material properties with concept function was key. Material 1 posed challenges in conforming to concave shapes or smaller curves, while Material 3's lightweight, elastic, and rollable nature suggested better suitability despite its prototyping difficulty. For designs intended to support weaker joints and align complex anatomical areas, precise fit and movement flexibility are essential. Future studies could explore computational tools like body scanning (Liu and Xu 2019), computational design (Fang 2020), and on-body fabrication (Gannon, Grossman, and Fitzmaurice 2016) for enhanced conformability.

Throughout, participants expressed concerns about the strength and durability of fungal textiles, with some worrying about the materials tearing under pressure. While participants prioritized functionality above other factors, the organic and natural aesthetic qualities of fungal textiles present an opportunity to move away from medical associations and foster stronger adherence. These insights highlight the need for further material development and optimization, likely in an industry setting, to fully meet application demands.

As a pilot study with seven participants, these findings offer preliminary, non-generalizable insights into experiential aspects of fungal textiles for orthopaedic use. Given the small sample size, potential selection bias, lack of mechanical and long-term usability testing, conclusions regarding functionality and user acceptance remain provisional.

Nonetheless, the study offers early insights into the potential of fungal textiles and lays the groundwork for more detailed research. Future work includes technical testing (e.g. tensile strength) and deeper exploration of experiential qualities highlighted in this study. Interdisciplinary collaboration with experts in biology, materials, assistive technology, and physical therapy will be crucial for advancing applications. Designers will play a critical role in shaping form and function, socializing fungal textiles as viable materials, and bridging technical, creative, and sociological research.

5.2. Semantic and therapeutic opportunities

Fungal materials, like other living and bio-fabricated materials, are often associated with decay, fragility, and impermanence (Ertürkan, Karana, and Mugge

2022; Kim et al. 2023). Ethnographic studies highlight fungi's polarizing societal perceptions, ranging from aversion to fascination—a dichotomy termed “mycophobia-mycophilia” (Wasson and Wasson 1957, via Ruan-Soto et al. 2013). Associations with decomposition and dirt (Van Den Broek, Rovers, and Calcan 2024) may conflict with expectations of safety and hygiene, particularly for on-skin therapeutic garments (Kim et al. 2026). However, study participants' associations with nature, fashion, and the organic, appeared to override these preconceptions. Direct engagement with the material through our participatory method helped demystify it, suggesting that user involvement is key to overcoming semantic barriers and supporting broader adoption.

This participatory approach also aligns with inclusive design principles through involving users in the design process (Herriott and Cook 2014). While this study gathered user requirements through exploratory interviews (Fang 2020) and feedback insights through the material experience interviews rather than full co-design, the conformal fabrication methods outlined in Fang, Parisi, and Karana (2026) could enable greater user agency in customizing differential patterning of the material. Drawing from critical disability studies (Mankoff, Hayes, and Kasnitz 2010), we acknowledge that assistive technologies should not only provide support but also challenge stigmatizing assumptions about normality, bodies, and aesthetics. Applying universal design strategies to bio-materials like fungal textiles could promote wellness and sustainability for a variety of users, not just those in need of assistance. As scholars have argued, assistive technologies often reflect dominant cultural ideas about normalization and control (Costanza-Chock 2020); alternative materialities may offer openings for resistance and redefinition.

While this study was designed to elicit the immediate responses and material experiences of participants, other benefits of fungal textiles may only be truly understood through more sustained evaluation. Prior work suggests that fungal materials' natural qualities may offer psycho-physiological benefits tied to biophilia (Van Den Broek, Rovers, and Calcan 2024). Beyond perceptions, species including *Ganoderma lucidum* and *Fomes fomentarius*, used in traditional medicine, exhibit therapeutic properties like anti-inflammatory and antimicrobial effects (Ekiz et al. 2023; Pegler 2001). Other species, like *Ganoderma taugae* and *Phellinus linteus* have demonstrated their efficacy in wound care, treatment of skin conditions like atopic dermatitis (Hwang et al. 2012; Suarato, Bertorelli, and Athanassiou 2018), and their skin-contact benefits, including anti-inflammatory, antioxidant, and anti-tumor properties (Manan et al. 2021). While our study focused on non-living artefacts, it remains unclear whether the expression of such therapeutic qualities in fungal textiles occurs only when they are maintained alive, i.e. metabolically active, or reactivated from a dormant state (Elsacker et al. 2025), potentially resulting in living therapeutic skins (Kim et al. 2026). Future research

could examine these potential benefits by evaluating user responses and the long-term usability of fungal textiles through methods like biological monitoring and longitudinal studies.

5.3. Fungal textiles for regenerative ecologies

Fungal textiles align with circular design principles being renewable, biodegradable, and compostable (Lazaro Vasquez and Vega 2019; Danninger et al. 2022). Their life cycle, from material production to decomposition, enriches the soil and supports other organisms (Bell et al. 2024). In this sense, fungal textiles are not just circular but regenerative materials (Karana et al. 2023). Their impermanence could be a benefit rather than a drawback in this context, aligning the material lifecycle with the temporary functional lifespan of orthopaedic garments used by many participants in this study. Their degradation offers more apparent visual signals of wear, highlighting areas of excessive strain as garments near the end of their structural lives. Furthermore, dormant fungal textiles retain the potential for repair, self-healing when rehydrated or placed in nutrient media (Elsacker, Zhang, et al. 2023), to extend the product lifecycle. Fungal textiles thus present an opportunity for garments that are adaptive and integrated into regenerative material systems.

The organic aesthetics noted by participants further suggest that fungal textiles might shift social practices and cultural perceptions in materials, bridge cognitive separations of humans from nature, and help resolve stigmas around microbial organisms for more holistic worldviews (Karana et al. 2023). Designing with fungal textiles, not just as functional materials, but as cultural agents can help scaffold new relationships between humans and the living world for more-than-human sensibilities. Future work should build on participant insights on the affordances of fungal textiles to explore how they might elicit new social practices, challenge norms, and enable relational care and repair towards regeneration.

6. Conclusion

This study highlights fungal textiles as a promising material in orthopaedic garments for individuals with musculoskeletal challenges, injuries, or in search of preventative support. These conditions often affect daily functioning, and while devices like braces, splints, and compressive gloves can alleviate symptoms, their adoption is hindered by issues like discomfort due to material, lack of personalization, sociocultural clashes, and conspicuous designs. Our system of fungal textile artifacts responds to these challenges by offering customizable differential support and insulation, with adaptability to users' changing needs over time.

Study participants highlighted how these materials could be modularly reconfigured for desired qualities to suit lightweight or more intense use with differing degrees of breathability and cushioning. They responded to the patterns and forms with positive aesthetic connotations ranging from organic or active to relaxing or fashionable. The natural aesthetics and capacity for sustainable, regenerative production of fungal textiles provides a compelling alternative to synthetic materials. Beyond functionality, fungal textiles invite a rethinking of the role of materials in assistive garments from detached, medicalized supports towards living, responsive artifacts that engage users in ongoing care and co-adaptation to better serve human and planetary health.

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