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Innovative Textile Solutions in Managing Atopic Dermatitis: A Comprehensive Review of Therapeutic Garments

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Abstract

Atopic dermatitis (AD) is a chronic inflammatory skin condition that significantly impacts patients' quality of life. Traditional treatment options often focus on pharmacological interventions, but there is increasing interest in non-pharmacological approaches, such as therapeutic garments. This review examines the role of therapeutic garments in managing AD symptoms through various fabric technologies and designs. It highlights the effectiveness of anti-inflammatory, moisturizing, and breathable fibers, including aloe vera, bamboo, and superfine Merino wool, which contribute to improved skin microenvironments and symptom relief. Patient preferences, comfort, and adherence to wearing these garments are essential factors influencing treatment outcomes. Economic considerations, such as cost-effectiveness and insurance coverage, also impact accessibility to therapeutic garments. Future research should focus on optimizing fabric choices, enhancing user experience, and exploring the combined effects of these garments with existing treatments. Ultimately, the integration of advanced textile technologies and patient-centered design in therapeutic garments may lead to better management of AD, improving overall patient well-being.

Keywords: Atopic Dermatitis, Therapeutic Garments, Textile Technology, Antibacterial Properties, Breathable Materials

Introduction

Atopic dermatitis (AD) is a chronic inflammatory skin condition(Laughter et al., 2021) that significantly affects patients' quality of life (Misery et al., 2007). Characterized by dry skin, itching, and erythema, AD has a profound psychological and emotional impact, often leading to sleep disturbances, anxiety, and social limitations(Langan et al., 2020). The incidence of atopic dermatitis is very high within one year of age, with more than 50% of children developing the disease within one year of age, and the disease is chronic, often extending into adulthood. It is also classified as simple and mixed atopic dermatitis. As for the etiology, there may be more factors associated with atopic dermatitis, such as genetic factors, immune abnormalities or environmental factors, including abnormal skin barrier function in children,

which are common causes of atopic dermatitis. There are three clinical phases: acute or subacute eczema in infancy; and subacute or chronic eczema in childhood and young adulthood. Since there is no complete cure for this condition(Arkwright et al., 2013), research on daily wear is necessary to assist patients in managing the disease process and improving the quality of life of AD patients.

A large and growing body of literature has investigated which fabric(Jaros et al., 2020) is benefices for AD patience. Atopic dermatitis, also known as eczema, is a chronic skin condition that can cause dry, itchy, and inflamed skin. The current market summer clothing fabrics are mainly classified as figure 1.

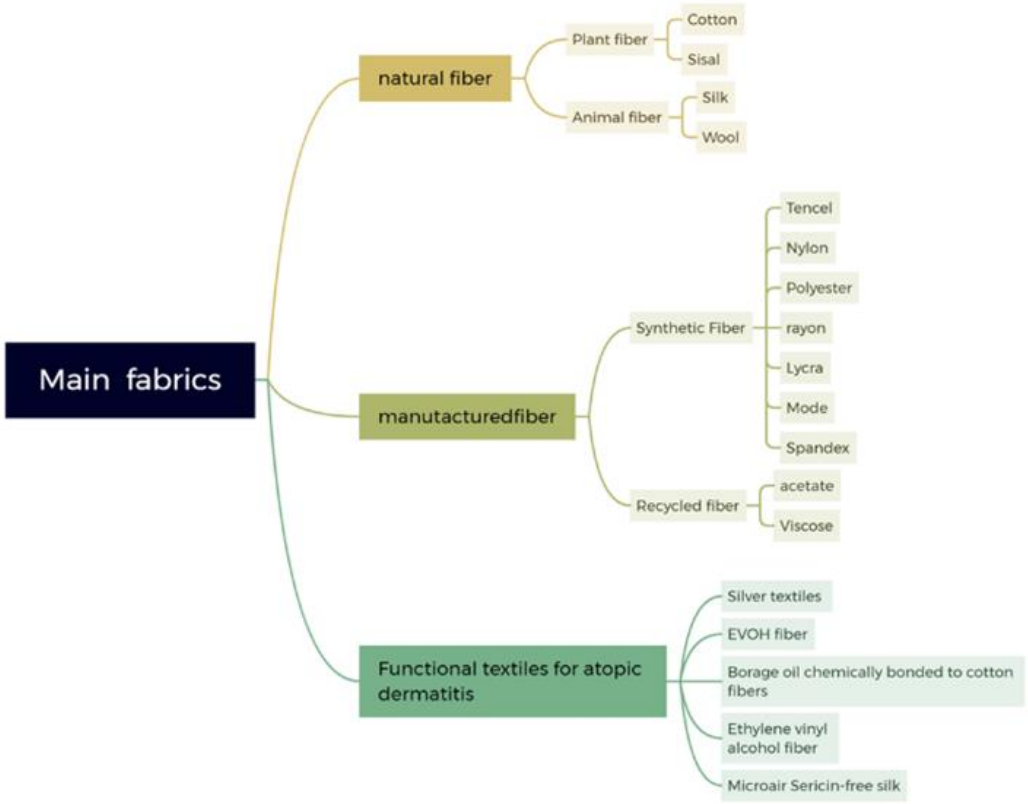

Figure 1 The current market summer clothing fabrics are mainly classified

Traditional treatments primarily focus on pharmacological interventions; however, there is growing interest in non-pharmacological approaches, such as therapeutic garments (K. S. Thomas et al., 2017)designed to alleviate AD symptoms. These garments aim to improve the skin's microenvironment through specific fabric technologies(Chinevere et al., 2008), including antibacterial, anti-inflammatory, and moisturizing properties.

This review aims to evaluate the role of therapeutic garments in managing AD by examining their characteristics, historical development, and effectiveness based on clinical studies. The impact of clothing on patients with AD, including triggers and therapeutic potential, will also be discussed, with a focus on the challenges and opportunities for developing therapeutic garments in tropical climates like Malaysia.

Methods

This narrative review synthesizes research on therapeutic garments for atopic dermatitis (AD) management, emphasizing tropical climates like Malaysia. Literature from 1990 to 2024 was retrieved from PubMed, Google Scholar, Scopus, and Web of Science, spanning key developments in textile technology. English and Chinese articles were included to capture global and regional perspectives. Search terms encompassed "Atopic dermatitis," "Therapeutic garments," "Antibacterial fabrics," and "Tropical climates and dermatitis." Studies were categorized into fabric technologies, comfort, clinical outcomes, and environmental adaptations. Inclusion focused on AD-specific garments and tropical relevance, excluding purely pharmacological studies or those with weak methodology (n<10). Data were analyzed thematically to elucidate garment efficacy. No ethical approval was required for this secondary analysis; included studies were verified for ethical compliance to minimize bias.

Literature Search Strategy

A targeted search of the literature was performed using multiple electronic databases, including PubMed, Google Scholar, Scopus, and Web of Science. The search focused on articles published from 1990 to 2024, providing a comprehensive view of developments over the past few decades. Both English and Chinese articles were included to ensure broad coverage of studies and discussions. Search terms included: Atopic dermatitis, Eczema, Therapeutic garments, Antibacterial fabrics, Moisturizing textiles, Clothing and eczema management, Tropical climates and dermatitis, Fabric technology for skin health.

Categorization Approach

Rather than systematically evaluating all studies, this review categorizes the literature into distinct themes based on specific features of therapeutic garments and their relevance to AD management. These themes include:

1) Fabric Composition and Technologies: Analysis of the types of fabrics (e.g., cotton, silk, synthetic fibers) and technological treatments (e.g., antimicrobial, moisturizing, anti-inflammatory properties).
2) Comfort and Wearability: Exploration of studies on patient-reported comfort, garment breathability, and durability, especially in hot and humid conditions.
3) Clinical Outcomes: Categorization of studies based on outcomes such as symptom relief, skin hydration, bacterial reduction, and overall quality of life in AD patients.
4) Environmental Adaptations: Focus on research that examines the efficacy of therapeutic garments in tropical climates like Malaysia, with an emphasis on how heat and humidity influence AD symptoms and the performance of different fabrics.

Inclusion and Exclusion Criteria

Inclusion Criteria

1) Articles examining the role of therapeutic garments in managing AD.
2) Studies highlighting fabric composition, garment technologies, and their impact on skin health.
3) Research that discusses the use of garments in tropical or humid climates.
4) Clinical outcomes related to symptom reduction, skin hydration, and quality of life improvements for AD patients.

Exclusion Criteria

1) Research focusing solely on pharmacological treatments for AD.
2) Studies with fewer than 10 participants or lacking robust methodology.
3) General clothing studies unrelated to skin conditions.

Data Categorization and Analysis

The selected articles were categorized into thematic groups to aid in narrative synthesis. Data points from each study, including fabric composition, technological treatments, patient-reported outcomes, and clinical findings, were analyzed within these categories to provide a holistic understanding of how therapeutic garments contribute to AD management.

Key Themes for Analysis

1) Fabric Composition and Technology: The various types of fabrics and their properties (antimicrobial, hypoallergenic, moisturizing) were critically evaluated to understand their suitability for AD patients.
2) Comfort and Wearability: This section of the review highlights user feedback, focusing on comfort in daily wear, durability, and how garments perform under tropical conditions.
3) Clinical Relevance in Tropical Climates: Studies were grouped based on their geographical relevance, focusing on how garments fare in regions with high heat and humidity, such as Malaysia.

Ethical Considerations

As this review relies on secondary sources from published research, no ethical approval was required. However, all studies included were screened to ensure they adhered to ethical standards, particularly clinical trials that involved human subjects.

This narrative review aims to offer a structured but flexible overview of the development, effectiveness, and limitations of therapeutic garments in the context of AD, with a specific focus on their performance in tropical environments. The thematic approach helps to illuminate specific areas of progress and ongoing challenges in the field.

Results

Characteristics of Therapeutic Garments

Definition and Key Features of Therapeutic Garments

Therapeutic garments refer to clothing specifically designed to treat and alleviate the symptoms of atopic dermatitis (AD). These garments typically possess the following features: **Comfort**: Made from soft, breathable fabrics to reduce friction and irritation on the skin. Characteristics of clothing fabrics shown in Table 1

Table 1
Characteristics of Clothing Fabrics

English Name	Attributes	Disadvantages
Cotton	Good moisture absorption, moisture discharge is also fast, not easy to produce static electricity heat conduction, rapid heat dissipation, wearing cool, sweat is not close to the body, more resistant to washing, heat resistance is good.	Poor elasticity, easy to crease, easy to shrink, easy to fade, easy to deformation
Silk	Smooth and soft, glossy, good extensibility, good heat resistance, not resistant to salt water leaching, should not be treated with chlorine bleach or detergent.	Not resistant to sweat, not wear-resistant, not resistant to high temperature, easy to fade and yellow, easy to become brittle, easy to hang silk
Polyester	1, sun shading, light transmission, good ventilation: polyester fiber can eliminate up to 86% of the solar radiation, but also to keep the indoor air flowing, and can clearly see the outdoor scenery. 2, strong heat insulation: polyester sun fabric has good heat insulation properties that other fabrics do not have, greatly reducing the use of indoor air conditioning. 3, UV protection: polyester sun fabric can resist up to 95% of UV rays. 4, fire: polyester fabrics have other fabrics do not have flame retardant properties, real polyester fabrics will remain after burning the internal skeleton glass fiber, so will not be deformed, and ordinary fabrics after burning without any residue. 5, moisture-proof: polyester fiber can make bacteria can not reproduce, so the fabric will not be stored mold. 6, wrinkle and conformability is very good: has a high strength and elastic recovery, its firm and durable, wrinkle-free, non-stick hair, color fastness is very good, by which the textile fabric not only fastness than other fibers 3-4 times higher, and brace, not easy to	1, poor moisture absorption: wearing a stuffy feeling, while easy to bring static electricity, staining dust, affecting the beauty and comfort. 2, polyester fabric fusion resistance is poor: encounter with soot, sparks and other easy to form holes. Therefore, polyester fabrics should try to avoid contact with cigarette butts, sparks, etc. when wearing. 3, easy to generate static electricity: polyester fiber is easy to generate static electricity, need to use softener soak cleaning, after washing easy to shade dry, not to be exposed to the sun, so as to avoid wrinkles due to heat.

	deformation, there is a "non-iron" reputation. 7, easy to clean: can be placed in water to brush, but also easy to dry. 8, tear resistance: no reinforcement, natural tear resistance, significant wind resistance and withstand frequent use.	
Spandex	Excellent elasticity, good elasticity, smooth hand feeling, small moisture absorption, good weather and chemical resistance, machine washable, poor heat resistance.	Low strength, poor moisture absorption
Nylon	Dyeing is better, wearing light, but also has good waterproof and windproof performance, high wear resistance, strength and elasticity are very good.	Poor breathability, poor moisture absorption, poor heat resistance, easy to static electricity
linen	It is good moisture absorption, moisture discharge is also fast, not easy to produce static electricity heat conduction, rapid heat dissipation, wearing cool, sweat is not close to the body, more resistant to washing, heat resistance is good.	Prickly feeling, easy to wrinkle, easy to break, easy to shrink, poor dyeability
Tencel	It is moisture-absorbing and breathable, draping fabric, smooth silk, bright dyeing and other characteristics. Repeated washing, sunlight also does not lose many health care functions, not easy to pilling.	Tencel fabrics are sensitive to temperature and can easily harden in hot and humid environments, while the picking of pile in cold water is poor.
rayon	Medium to high strength heavy fiber, so whether it is polyester or nylon will have good wear resistance, and this fiber is hydrophilic fiber, in terms of moisture absorption is very good, the fabric is not as comfortable as cotton, the overall feeling will be hard, in the whole process of wearing and washing is not the phenomenon of pilling and static electricity	Wet rayon will lose 3 to 5 percent of the strength, so the wet clothes can not be stretched, and when the clothes dry strength can be restored, rayon will shrink after a period of time and wrinkling phenomenon

Model	1、The raw material of modal fiber comes from the wood of nature, which can be naturally degraded after use. 2、Modal fiber is soft, glossy, colorful, the fabric feels especially smooth, the fabric surface is shiny and bright, drapability are better than the existing cotton, polyester, rayon, with silk-like luster and feel, is a natural mercerized fabric. 3, Modal fiber has the strength and toughness of synthetic fiber, dry strength 35.6cn, wet strength 25.6cn. strength is higher than cotton, polyester cotton, reducing the phenomenon of head breakage in processing. 4, Modal fiber moisture absorption capacity is 50% higher than cotton fiber, which makes Modal fiber fabric can be kept dry and breathable, is the ideal fabric for intimate fabrics and bedding, which is conducive to human physiological circulation and health. 5, Modal fiber has good morphological and dimensional stability compared with cotton fiber, which makes the fabric with natural wrinkle resistance and non-iron, making it more convenient and natural to wear. 6, modal fiber dyeing performance is better and after many washes still remain bright as new, and moisture absorption and thorough, good color fastness, compared with cotton, more comfortable to wear, no cotton clothing easy to fade, yellowing shortcomings. Therefore, the fabric color is bright, fabric taking performance is stable, and cotton fabric together after 25 times of washing, the feel will be more and more hard. Modal fiber fabric is the opposite, the more you wash the softer, the more you wash the brighter.	A little disadvantage is that the expansion is poor
Lycra	Lycra fabric as an important chemical fiber fabric, has other fabrics unmatched advantageous characteristics, including good elasticity, not easy to deformation is its biggest advantage, whether it is pure Lycra fabric or blended with other fibers into the fabric, are very close to the body	A Lycra fabric must be blended with other fibers in order to shape, otherwise it is difficult to become a fabric that can be used directly; secondly, Lycra fabric is slightly inferior in softness

	comfortable, with strong elasticity and recovery, in addition, Lycra fabric also has a wide range of applications, high comfort, relaxation, style design freedom and many other advantages.	compared with modal, cotton and other materials; finally, the service life of Lycra fabric is shorter.
acetate	There are strong moisture absorption, good breathability, high resilience and other advantages, and not easy to generate static electricity, and not easy to pilling, a strong sense of luster, color and very bright, silky touch against the skin is very comfortable, performance is not lost to the mulberry silk, has a good thermoplastic, dyeability	The fabric is more expensive, while the washing method needs attention, generally not suitable for washing, if the wet state strength will drop more obvious, so may be less resistant to scratch or wear.
Wool	Good touch, good crease resistance, good gloss, high warmth	Easy to shrink, poor heat resistance, not corrosion resistant, not easy to maintain, easy to static electricity
Viscose	Good dyeing performance, good fastness, soft fabric, high specific gravity, good drape, good moisture absorption, cool to wear, not easy to produce static electricity, lint and pilling.	Low strength, poor elasticity, easy to deformation and shrinkage
bamboo	An environmentally friendly fiber, bamboo has antibacterial anti-purple line characteristics, in the fiber purification process with high-tech technology to protect with natural antibacterial antibacterial, deodorant and anti-ultraviolet substances, with strong breathable, fabric drape, silk smooth, bright dyeing, antibacterial, deodorant, anti-ultraviolet, repeated washing and drying also does not lose many functions.	Easy to break

Lyocell	1、Lyocell fiber has the luxury of wool fabric and the drape of modal in appearance, and the surface is bright and shiny very suitable for making high-grade women's clothing. In the washing, anti-pilling, shrinkage rate is very small. 2, lyocell fiber is the primary advantage of its green environmental performance, lyocell fiber is not only the raw material is natural plant fiber, and in the process there is no chemical reaction, so the environment and health are beneficial, can be used with confidence. So we also say that Leyser fiber is a kind of green fiber fabric. 3、Lyocell fiber has the warmth of wool, no static electricity, and anti-allergy in wearing. At the same time, it has the softness of cotton and the high strength of polyester, and is resistant to wear.	1, easy to hook silk up holes, the higher the composition of the clothing containing Lysol, the more likely such a situation. 2, washing delicate, dry in the shade, not wringing, do not contact acidic and alkaline detergent. 3, the fabric needs to be hand-washed at low temperature, can not dehydration, can not be exposed to the sun

- **Antibacterial properties**: Incorporates antibacterial materials to help reduce the number of bacteria on the skin, particularly *Staphylococcus aureus*, which is associated with worsening AD symptoms.
- **Moisture retention**: Some therapeutic garments are designed to help keep the skin hydrated, reducing dryness and itching.
- **Hypoallergenic**: Avoids the use of materials that could trigger allergic reactions, such as certain chemical dyes or metal fasteners.

The primary goal of therapeutic garments is to provide an adjunctive treatment for AD, improving the skin's microenvironment to alleviate symptoms and enhance the patient's quality of life.

Historical Development

The development of therapeutic garments has evolved from traditional fabrics to modern functional textiles. Initially, doctors recommended natural materials such as cotton and silk due to their skin-friendly and comfortable qualities. As scientific understanding and textile technology advanced, modern therapeutic garments began incorporating features such as antimicrobial, anti-inflammatory, moisture-wicking, and soothing properties.

- **1990s**: The first therapeutic garments for AD patients appeared, primarily using traditional fabrics like cotton and silk.
- **2000s**: With deeper insights into AD pathophysiology, synthetic fabrics with antibacterial and anti-inflammatory properties were introduced.
- **2010s**: The research and development of therapeutic garments accelerated, with innovative fabrics such as silver-coated, chitosan-coated, and cellulose-based materials showing potential in reducing AD severity and *Staphylococcus aureus* load.

In recent years, the study of therapeutic garments has increased, with systematic reviews and meta-analyses evaluating the impact of various fabrics on AD symptoms. These studies

provide scientific evidence for the design and selection of therapeutic garments, advancing the field.

Atopic Dermatitis (AD) and Clothing

Impact of AD on Patients' Quality of Life

Atopic dermatitis (AD) is a common chronic inflammatory skin condition characterized by dry skin, itching, and erythema. AD significantly impacts patients' quality of life (QoL), with studies showing that the burden on AD patients is comparable to that of other chronic conditions like diabetes and heart disease.

- **Decline in QoL**: AD patients often experience sleep disturbances, emotional distress, and social limitations, all of which contribute to a reduced quality of life. A systematic review and meta-analysis found that QoL scores in AD patients were significantly lower than those of healthy controls(Birdi et al., 2020) .
- **Psychological impact**: Higher rates of depression and anxiety are reported in AD patients, further affecting their daily lives and social functioning (Talamonti et al., 2021).
- **Economic burden**: The management of AD requires continuous medical resources, including medications, skincare products, and consultations, placing an economic strain on patients and their families (Torrelo Fernández et al., 2024) .

Clothing as a Trigger for AD

AD patients have highly sensitive skin, and inappropriate clothing can trigger AD symptoms.

- **Rough fabrics**: Wool and synthetic materials can cause overheating, sweating, and irritation, triggering itchiness (Rohani Shirvan et al., 2022)
- **Chemical dyes**: Dyes and finishing agents used in clothing can cause allergic reactions and exacerbate AD symptoms.
- **Tight clothing**: Tight or non-breathable clothing can restrict air circulation and increase friction, leading to skin irritation.

Clothing as a Therapeutic Tool for AD

Therapeutic garments can act as an adjunctive tool in managing AD symptoms by:

- **Using natural materials**: Cotton and silk are recommended for AD patients due to their softness and breathability (Fowler et al., 2019).
- **Antibacterial treatment**: Some therapeutic garments are treated with silver or other antibacterial materials to reduce bacterial load on the skin (Fluhr et al., 2010).
- **Moisturizing fabrics**: Specialized fabrics are designed to retain moisture, reducing dryness and itching.
- **Hypoallergenic**: Therapeutic garments generally avoid using materials that may cause allergic reactions, such as certain chemical dyes or metal fasteners.

Studies have shown that appropriate fabric selection can reduce the severity and frequency of AD flare-ups. For example, superfine Merino wool and antibacterial-treated fabrics have been shown to benefit AD patients (Su et al., 2017a).

Types and Characteristics of Therapeutic Garments

Antibacterial Fiber Garments

Antibacterial fiber garments are designed to reduce the number of bacteria on the skin, which is crucial for AD patients, as bacterial infections often exacerbate AD symptoms. The current market summer clothing fabrics are mainly classified as table 1.

- **Silver ion fibers**: Silver ions are known for their antibacterial properties and are widely used in antibacterial fibers. A study showed that silver ion fibers effectively reduced the growth of *Staphylococcus aureus*, lowering the risk of skin infections in AD patients (Garza-Cervantes et al., 2020).
- **Nano-silver fibers**: Advances in nanotechnology have enhanced the antibacterial properties of silver. Nano-silver fibers can continuously release silver ions, providing long-lasting antibacterial effects (Rhim et al., 2006).
- **Chitosan fibers**: Chitosan is a natural polysaccharide with excellent antibacterial properties. Studies have demonstrated that chitosan fibers significantly reduce bacterial load on the skin of AD patients (Kumar et al., 2023).

Anti-Inflammatory Fiber Garments

Anti-inflammatory fiber garments help alleviate AD symptoms by reducing inflammatory responses in the skin.

- **Aloe vera fibers**: Aloe vera is known for its natural anti-inflammatory and soothing properties. Studies have shown that garments containing aloe vera fibers can reduce skin inflammation in AD patients (Surjushe et al., 2008).
- **White willow bark extract fibers**: White willow bark contains salicylic acid, a known anti-inflammatory agent. Garments made with these fibers can help reduce skin redness and itching(Gyawali et al., 2010).

Moisturizing and Breathable Garments

Moisturizing and breathable properties are essential for AD patients, as dry skin is a primary symptom of AD.

- **Polyamide fibers**: These fibers can absorb and lock in moisture on the skin's surface, reducing water evaporation and keeping the skin hydrated (Vasanthan, 2009).
- **Bamboo fibers**: Bamboo fibers have excellent breathability and moisture-wicking properties, helping to regulate skin humidity and reduce sweating and overheating (Gunasekaran et al., 2020).
- **Cotton and organic cotton**: Cotton fibers are ideal for AD patients due to their softness, breathability, and moisture-wicking properties. Organic cotton, grown without chemical pesticides, is less likely to trigger allergic reactions (Günaydin et al., 2019).

Clinical Studies on Therapeutic Garments

Clinical Trial Design

The clinical study of therapeutic garments typically follows the principles of randomized controlled trials (RCTs) to ensure the reliability and validity of results. Key elements of study design include:

- **Randomization**: Participants are randomly assigned to either the treatment or control group to minimize selection bias.
- **Control group**: Standard care or placebo garments are used as controls.
- **Double-blind**: Both researchers and participants are unaware of who receives the experimental treatment or control, reducing measurement bias.
- **Multi-center**: Studies are conducted across multiple centers to increase the representativeness of the sample and external validity of the study.
- **Long-term follow-up**: The long-term effects and safety of therapeutic garments are evaluated over an extended period.

For example, one study designed a 6-month randomized controlled, double-blind, multi-center trial to compare the efficacy of antibacterial therapeutic garments made from silver ion or chitosan fibers with non-antibacterial garments in patients with moderate to severe AD (Thomas et al., 2017).

Evaluating Treatment Outcomes

Treatment outcomes are typically evaluated in several ways:

- **Symptom improvement**: Changes in rash area and severity are assessed using tools such as the Eczema Area and Severity Index (EASI)(Hanifin et al., 2001).
- **Quality of life**: Questionnaires assess improvements in patients' quality of life (Lewis & Finlay, 2004).
- **Microbial load**: Changes in the number of bacteria, such as *Staphylococcus aureus*, on the skin are evaluated (Pothmann et al., 2019).
- **Skin physiological parameters**: These include skin moisture content, pH, and transepidermal water loss (TEWL) (Knor et al., 2011).

For example, one study found that children's AD symptoms improved with the use of superfine Merino wool, suggesting that modern textile technology and finer, smoother fibers may benefit AD patients(Su et al., 2017a).

Safety and Tolerability

Safety and tolerability are critical considerations in the clinical study of therapeutic garments. Research needs to evaluate:

- **Skin irritation**: Assess whether the garments cause skin irritation or allergic reactions (Jaros et al., 2020).
- **Long-term wear comfort**: Evaluate the comfort and acceptance of therapeutic garments during long-term wear (Fenton & Al-Salama, 2021).
- **Side effects**: Document any potential side effects, such as skin dryness or worsened itching.

Studies suggest that traditional cotton and silk fabrics show mixed results in improving AD symptoms but are generally considered safe(S. Thomas et al., 2011). Superfine Merino wool has been shown to be non-irritating and may be recommended as an alternative (Su et al., 2017b).

Patient Preference Survey

The personal preferences of patients play a significant role in the selection of therapeutic garments. Studies have shown that patient preferences can influence adherence to treatment.

- **Fabric Preferences**: A study (Love & Nedorost, 2009) investigated the fabric preferences of AD patients and found that most patients tend to prefer soft, breathable fabrics that are less irritating to the skin, such as cotton and silk.
- **Comfort**: Comfort is the primary consideration when patients choose therapeutic garments. Patients typically prefer garments that do not exacerbate itching and irritation (Jaros et al., 2020).
- **Style and Design**: In addition to functionality, patients also care about the style and design of garments. Fashionable and comfortable designs can boost patients' confidence and improve their overall experience with wearing the garments (Yang et al., 2020).

Long-Term Adherence to Wearing

Long-term adherence to wearing therapeutic garments is a key factor influencing treatment outcomes:

- **Barriers to Adherence**: Uncomfortable clothing, unappealing designs, or inconvenience in wearing the garments may cause patients to not comply with long-term wear recommendations(Dagenet et al., 2024).
- **Improving Adherence**: Offering customization services, educating patients on the importance of therapeutic garments, and providing financial incentives can improve patient adherence (Shahin et al., 2019).

Economic Burden and Accessibility

The cost of therapeutic garments may impose a financial burden on patients, affecting accessibility:

- **Cost-Effectiveness**: Although therapeutic garments may require a higher initial investment, they could reduce the use of medical resources over time, thus saving costs in the long run(Fasseeh et al., 2022).
- **Insurance Coverage**: Health insurance coverage of therapeutic garments can significantly lower patients' financial burden and increase accessibility to treatment (Chiesa Fuxench et al., 2019).
- **Patient Economic Status**: Patients with limited financial means may be unable to afford therapeutic garments, restricting their access to effective treatments (Simpson et al., 2018).

Therapeutic Garments in Tropical Malaysia

Climate Considerations

The hot and humid climate of tropical regions such as Malaysia presents additional challenges for AD patients. High temperatures and humidity can exacerbate sweating, leading to increased irritation, itching, and flare-ups. AD patients in tropical climates must carefully choose clothing to minimize discomfort and avoid worsening their condition (Tan et al., 2020). In Malaysia, the average temperature ranges from 25°C to 32°C, with humidity levels often exceeding 80%. Such conditions are conducive to excessive sweating, which can irritate AD-prone skin. The design and material composition of therapeutic garments must therefore be optimized for use in tropical climates. Specifically, garments should:

- Be lightweight and breathable to enhance air circulation.
- Wick away moisture to prevent sweat accumulation.
- Include antibacterial properties to combat the increased bacterial growth associated with sweat and heat(Ragamin et al., 2021).

Fabric Selection for Tropical Conditions

Several fabrics have been studied for their suitability in tropical environments, particularly in the context of AD:

- **Cotton**: Cotton is widely used due to its breathability and softness, but it has limited moisture-wicking properties, which may cause discomfort in humid conditions(Atalie & Rotich, 2021).
- **Bamboo fiber**: Bamboo is an alternative natural fiber known for its moisture-wicking capabilities and breathability, making it suitable for tropical climates(Gunasekaran et al., 2020). However, more research is needed to confirm its effectiveness for AD patients.

- **Modal**: Modal, a type of rayon, has excellent breathability and moisture-wicking properties. It has been shown to help keep the skin dry and cool, reducing irritation in hot climates (Latif et al., 2019).
- **Silver-coated fabrics**: Fabrics coated with silver ions have been proven effective in reducing bacterial load on the skin. A study conducted in a hot and humid environment demonstrated that silver-coated fabrics significantly reduced skin infections in AD patients compared to untreated fabrics (Erdem & Rajendran, 2016).

Challenges and Opportunities

The development of therapeutic garments for AD in tropical regions like Malaysia presents several challenges:

- **Thermal comfort**: Ensuring that garments provide both cooling and comfort while maintaining their therapeutic properties.
- **Affordability**: Many therapeutic garments, especially those with advanced fabric technologies, are expensive, limiting their accessibility to patients in lower-income regions (Chiesa Fuxench et al., 2019).
- **Cultural preferences**: Clothing preferences may vary by culture, and adapting therapeutic garments to local styles while maintaining their efficacy is crucial for patient adherence(Moy et al., 2003).

Despite these challenges, tropical regions also offer opportunities for innovation in garment design. New fabric technologies and collaborations between local manufacturers, dermatologists, and textile researchers can lead to the development of more affordable, comfortable, and effective therapeutic garments tailored to the needs of AD patients in tropical climates.

Discussion

The review underscores the potential of therapeutic garments as a non-pharmacological adjunct to the management of atopic dermatitis. The integration of advanced textile technologies has enabled the design of garments that cater to the specific needs of AD patients, providing comfort, reducing bacterial load, and maintaining skin hydration. Clinical evidence supports the effectiveness of these garments, but variability in individual responses highlights the necessity for personalized approaches.

However, barriers to adherence remain, including garment comfort, style, and economic factors. Ensuring accessibility through health insurance coverage and cost-effectiveness analysis is critical to improving treatment outcomes for AD patients. Future research should aim to optimize fabric choices, enhance patient adherence strategies, and explore synergistic effects with existing treatment modalities.

In conclusion, therapeutic garments present a valuable addition to the multifaceted approach required for effectively managing atopic dermatitis, particularly in tropical environments. Multidisciplinary collaboration between dermatologists, textile engineers, and material scientists is essential to develop innovative solutions that enhance patient well-being and quality of life.

Conclusion

Scientific Basis of Therapeutic Garments

Therapeutic garments offer a non-pharmacological treatment option for AD patients, with their scientific foundation rooted in the ability of special materials and technologies to improve the skin microenvironment, reduce symptoms, and enhance quality of life. Advances in modern textile technologies have enabled therapeutic garments to combine features such as comfort, antibacterial properties, moisture retention, and hypoallergenicity, providing more options for AD patients.

Clinical Effectiveness of Therapeutic Garments

Clinical studies have shown that certain therapeutic garments can significantly improve the skin condition and quality of life of AD patients. For example, superfine Merino wool and antibacterial-treated fabrics have demonstrated benefits for AD patients. However, the effects of different fabrics vary, and more research is needed to determine the optimal treatment approaches.

Importance of User Experience

Patient preferences and experiences are crucial in the selection and adherence to therapeutic garments. Comfort, style, and cost are the primary factors patients consider. Improving adherence requires addressing these factors comprehensively and providing personalized solutions.

Challenges of Economic Burden and Accessibility

The cost of therapeutic garments may place a financial burden on patients, affecting accessibility. Health insurance coverage and cost-effectiveness analyses are key to improving the accessibility of therapeutic garments. Future research and policy development need to consider these economic factors to ensure that all AD patients have access to effective treatments.

Future Research Directions

Future research should focus on the following areas:

- Evaluating the long-term effects of different fabrics on AD symptoms.
- Identifying the optimal design and material combinations for therapeutic garments.
- Investigating ways to improve patient adherence and the accessibility of therapeutic garments.
- Exploring the combined effects of therapeutic garments with other treatment methods (e.g., medication, phototherapy).

Research and development of therapeutic garments is a multidisciplinary field that requires close collaboration between dermatologists, textile engineers, material scientists, and patients. Through these efforts, more effective and comfortable treatment options can be provided for AD patients, ultimately improving their quality of life.

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