Therapeutic Applications of Smart Textiles for Stress Relief and Mental Well-Being in Nigeria: An Exploratory Study of Design, Development, and User Experience

Grace Chizoma Onyebuchi-Igbokwe[1]*, Jovita Charles Ogu[2], Nwakwasi Rachel Nkeonyere[3], Chizoba Anderson Egornu[1], Felicia Chinyere Okwulehie[4], Bertha Oluchi Uzowuihe[5], Nnamdi Chibuzo Adibe[1] and Edem Peters[6]

[1]Department of Fine and Applied Arts, Alvan Ikoku University of Education, Owerri, Nigeria

[2]Department of Fine & Applied Arts, Alvan Ikoku Federal University of Education Owerri Nigeria

[3]Department of Agricultural Extension, Federal University of Technology, Owerri, Nigeria

[4]Department of Home Economics and Hospitality Management Education, Alvan Ikoku Federal University of Educaton, Owerri, Nigeria

[5]Department of Languages and Humanities, Alvan Ikoku University of Education, Owerri, Nigeria

[6]Department of Fine Arts and Design, University of Port Harcourt, Nigeria

*Corresponding Author: Grace Chizoma Onyebuchi-Igbokwe, Department of Fine and Applied Arts, Alvan Ikoku University of Education, Owerri, Nigeria.

Abstract

By combining technology and fabric for therapeutic purposes, smart textiles have become a cutting-edge approach to treating stress and mental health issues. The design, development, and user experience of smart textiles in Nigeria are examined in this study, with an emphasis on how well they relieve stress and promote mental health. The study uses an experimental methodology to examine the potential therapeutic advantages of interactive textiles with temperature control, biofeedback sensors, and aromatherapy features. Surveys and experimental trials were used to gather data, and the physiological and psychological reactions of users to smart fabrics were examined. To assess the effect of smart textiles on stress reduction and general mental health, statistical analyses such as regression analysis and ANOVA (Analysis of Variance) were carried out using SPSS (Statistical Package for Social Sciences). Although the quantitative results indicated a possible relationship between the use of smart textiles and stress reduction, the statistical significance was not clear. Qualitative input, however, showed strong perceived benefits and user approval. In order to maximize the design and accessibility of smart textiles as a supplemental stress-relieving intervention in Nigeria, the study suggested more research, the creation of policies, and cooperation amongst stakeholders. It was anticipated that the results would add to the expanding corpus of research on digital health interventions, highlighting the promise of smart textiles as an approachable and culturally appropriate way to manage mental health in Nigeria.

Keywords: Therapeutic Application; Smart Textiles; Stress Relief; Mental Well-being; Aromatherapy; Biofeedback Sensors

Introduction

In Nigeria, socioeconomic difficulties, unemployment, and a lack of access to quality healthcare have made mental health conditions like stress, anxiety, and depression serious public health concerns (Ogunsemi et al. 103). Alternative therapeutic treatments must be investigated because traditional stress management techniques like medicine and psychotherapy are either stigmatized or

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unavailable. In contrast to other forms of art, innovative coloring has the potential to not only appeal to our sense of sight alone, but also to evoke feelings that soothe human emotions, thereby enhancing good health, which in turn promotes healthy living, according to Onyebuchi-Igbokwe et al (127). This is because diverse forms of art expression have also been found to possess therapeutic benefits.

By combining sensors, microelectronics, and responsive materials, smart textiles—a new area of wearable technology—offer a viable remedy by delivering physiological input in real time as well as stimuli that promote relaxation (Cho and Park 45). To reduce tension and promote relaxation, these textiles make use of vibration treatment, heat control, biofeedback sensors, and other techniques (Brown 112). Studies have shown that smart textiles can effectively manage anxiety, lower stress-induced physiological reactions, and improve sleep quality, which has led to their widespread use in medical and wellness applications worldwide (Johnson et al. 239). However, despite the rising incidence of stress-related diseases, little is known about how they are being implemented in Nigeria. Examining the viability, efficacy, and user perceptions of smart textiles in this setting is crucial given the distinct sociocultural and economic elements affecting mental health in Nigeria.

By assessing the design, development, and therapeutic effects of smart textiles for stress alleviation in Nigeria, this study aims to close the information gap. Its specific goal is to apply statistical techniques, such as regression analysis and ANOVA, to examine the connection between the use of smart textiles and stress reduction. To ascertain the acceptability and practicality of these fabrics in Nigerian society, user experiences and perspectives will also be investigated.

This study adds to the expanding conversation on alternative mental health interventions by taking a multidisciplinary approach that incorporates textile technology, psychology, and healthcare viewpoints. For designers, medical professionals, legislators, and other stakeholders interested in creating and deploying smart textiles as a workable stress-reduction strategy in Nigeria, the results will offer insightful information. Additionally, this study supports international initiatives to provide creative, culturally appropriate, and easily accessible mental health solutions that enhance general well-being and supplement conventional therapies (Williams and Taylor 54).

Using an interdisciplinary approach that blends textile engineering, health sciences, and user experience design, this project seeks to investigate the potential of smart textiles in addressing stress reduction and mental well-being in Nigeria. The study will specifically concentrate on the creation and assessment of smart textile prototypes that incorporate stress-relieving functions including temperature control, biofeedback sensors, and diffusion of aromatherapy. This project will offer empirical evidence on the feasibility of smart textiles as a mental health intervention by evaluating user engagement and perceived effectiveness. In order to accomplish these goals, the study will adopt a mixed-method research methodology, gathering information on consumers' experiences with smart textiles through surveys, interviews, and experimental trials.

Regression analysis will be used to determine the association between the use of smart textiles and stress levels, and ANOVA will be used to evaluate differences in effectiveness among various user demographics. Quantitative data analysis will be carried out using SPSS. The findings will contribute to both scholarly discussion and real-world implementations in mental health interventions in Nigeria by providing insights into the acceptability, usability, and therapeutic advantages of smart textiles. This study will further knowledge of smart textiles' function in stress reduction and mental health by examining the nexus of design, psychology, and technology. It also aspires to educate healthcare practitioners, designers, and politicians on how to incorporate cutting-edge textile solutions within Nigeria's framework for mental health.

Problem statement

In Nigeria, mental health conditions like stress, anxiety, and depression have emerged as major public health issues. Over 7 million Nigerians are estimated by the World Health Organization (WHO) to be depressed, and stress-related disorders are common in all socioeconomic categories (World Health Organization 12). Due to a lack of funding, societal stigma, and inadequate mental health infrastructure, traditional mental health interventions like psychotherapy and medication are still generally unavailable (Gureje et

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al. 145). As a result, there is an increasing demand for creative and unconventional treatment modalities that are both successful and acceptable in the culture. A new approach is offered by smart textiles, which combine fabric and technology to offer therapeutic advantages. In Nigeria, stress and mental health issues continue to be major issues that impact people from a variety of backgrounds, including professionals, students, and healthcare workers.

Numerous socioeconomic factors, such as unstable finances, demanding jobs, academic pressure, and restricted access to mental health care, have been linked to the rising incidence of stress-related illnesses like anxiety and depression (Adepoju 98). Nigeria has one of the highest incidences of mental health issues in Africa, according to the World Health Organization (WHO), but the country's mental healthcare system is still woefully underdeveloped (World Health Organization 22). By investigating the design, development, and use of smart textiles for stress alleviation and mental health in Nigeria, this study is dtermined to close this gap. It will look at how users perceive smart textiles, conduct empirical analysis to gauge their efficacy, and offer data-driven suggestions for their deployment. The study would establish the connection between the use of smart textiles and stress reduction outcomes by utilizing statistical techniques like regression analysis and ANOVA. This will help to forward the conversation about alternative mental health solutions in Nigeria.

Research Objectives

1. To investigate the creation of smart textiles that are appropriate for the Nigerian context and have stress-relieving characteristics.
2. To assess how well smart textiles work to lower stress and enhance mental health.
3. To examine user opinions and experiences about the acceptability and utility of smart textiles for medical applications.
4. To employ statistical techniques, such as regression analysis and ANOVA, to evaluate the connection between the use of smart textiles and stress reduction.

Research Questions

1. What essential design elements are necessary for smart textiles to successfully alleviate stress in Nigeria?
2. To what extent do smart textiles help users reduce stress and enhance their mental health?
3. How are smart textiles for mental health therapies perceived and experienced by users?
4. What statistical connections, as shown by regression and ANOVA studies, exist between the use of smart textiles and stress reduction?

Literature Review

With their creative uses for health and wellbeing, smart fabrics have become a burgeoning area of wearable technology. To monitor physiological data, control temperature, and give users therapeutic stimuli, these textiles incorporate cutting-edge materials and embedded sensors (Lee and Chen 34). Smart textiles have been widely employed in medical applications, especially for rehabilitation therapy and patient monitoring, according to Gupta et al. (Gupta et al. 201). Stress management is one important area where smart fabrics have shown promise. According to research, biofeedback-based smart textiles that monitor physiological markers like skin conductance and heart rate variability can assist users in creating stress-reduction self-regulation techniques (Patel and Roy 87).

Furthermore, it has been demonstrated that smart textiles with thermal therapy and mild vibration induce relaxation reactions in people with anxiety disorders (Kim et al. 176).

The incorporation of smart textiles into everyday clothing has been studied in industrialized nations, allowing for ongoing stress monitoring and intervention. On the other hand, little study has been done to evaluate the viability and efficacy of these technologies in low-income environments, such as Nigeria (Adeyemi 133). This study gap emphasizes the necessity for regional studies that take infrastructure constraints, cultural attitudes, and cost into account.

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Additionally, the use of smart textiles in mental health treatment is consistent with current debates about non-pharmacological stress-reduction techniques. Researchers support non-invasive, wearable alternatives that offer real-time therapies because pharmacological treatments for anxiety and stress-related illnesses sometimes have negative side effects (Smith et al. 45). In light of Nigeria's dearth of mental health resources, smart textiles may offer a stigma-free, easily available stress-reduction option. Although smart textiles hold promise for stress management, there are still obstacles in the way of their broad adoption. Existing literature has emphasized issues such user comfort, price, and durability (Williams and Taylor 98). Furthermore, empirical research is required to confirm the efficacy of these textiles for a variety of user demographics, especially in areas with distinct socioeconomic dynamics like Nigeria.

By presenting actual data on the efficacy of smart textiles for stress alleviation in the Nigerian environment, this study seeks to advance previous research. The study will evaluate the statistical significance of smart textile therapies using quantitative analyses like regression and ANOVA, adding to both academic understanding and real-world applications in mental health technology.

Overview of Smart Textiles for Mental Well-Being and Stress Relief

E-textiles, another name for smart textiles, are textiles that have sensors and actuators built into them to offer interactive features like relaxation and stress reduction (Tao 67). These textiles are a promising option for managing mental health since they frequently include biometric monitoring, temperature control, and aromatherapy diffusion (Jansen and Röttger 89). While studies have examined their applications in wearable healthcare, research on their specific impact on stress alleviation in Nigeria remains sparse.

By combining digital technology and textile science, smart textiles provide solutions that improve people's health and well-being. These cutting-edge textiles have embedded sensors, actuators, and other interactive elements that allow for physiological signal response and real-time monitoring (Park and Jayaraman 102). Smart textiles have been developed to monitor stress markers including body temperature, skin conductance, and heart rate variability in relation to mental health, enabling prompt interventions (Rossi et al. 210).

Biofeedback technology is one of the most promising uses of smart textiles for stress reduction. Wearers can practice self-regulation skills like deep breathing or mindfulness exercises thanks to biofeedback-enabled clothing that measures physiological stress markers and gives instant feedback (Lopez et al. 85).

According to research, people who use biofeedback-based textiles report feeling less stressed and having more control over their emotions than people who use traditional relaxation techniques (Kim et al. 176). It has been demonstrated that thermotherapy-based smart textiles, in addition to biofeedback, encourage stress reduction and relaxation. The parasympathetic nervous system is stimulated by the warmth of these fabrics, which are embedded with heating elements or phase change materials. This results in decreased cortisol levels and improved relaxation (Smith et al. 45). With research showing its efficacy in lowering anxiety and muscle tension through tailored stimulation, recent advancements in textile-integrated vibration treatment also point to encouraging results (Williams and Taylor 98).

In Nigeria, smart textiles for stress management are still not widely used, despite these developments. Widespread adoption is hampered by elements including cost, cultural attitudes toward mental health technologies, and infrastructure issues (Adeyemi 133). To guarantee these technologies' long-term efficacy and adoption, user comfort and textile durability must also be given top priority (Gupta et al. 201). By assessing the usefulness, cost, and efficacy of smart textiles in the Nigerian setting, this study aims to close these gaps. The study will offer data-driven insights into how these textiles affect stress levels and user perceptions by utilizing empirical analyses, such as regression and ANOVA. This will ultimately help to promote their wider acceptance and incorporation into mental health programs.

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Theoretical Foundations

This study's theoretical framework was based on a number of important psychological and technology ideas that describe the ways in which smart textiles affect mental health and stress reduction. The Cognitive-Behavioral Model of Stress and Coping is one such theory that contends that stress results from a person's assessment of environmental stressors and their perceived capacity for coping (Lazarus and Folkman 22). By offering real-time physiological feedback and encouraging relaxation, smart textiles—especially those that use biofeedback and thermal regulation—can improve coping strategies.

Furthermore, a neuroscientific viewpoint on how smart textiles can help reduce stress is offered by the Polyvagal Theory. According to this idea, the vagus nerve is essential for controlling the autonomic nervous system, and specific stimuli, like mild vibrations or heat, can trigger the parasympathetic response, which lowers stress and encourages relaxation (Porges 145). According to this notion, wearable smart textiles that incorporate regulated temperature modulation or vibration treatment are beneficial at reducing stress.

Understanding user acceptance of smart textiles for mental health also requires an understanding of the Technology Acceptance Model (TAM). Davis (68) asserts that perceived utility and usability have an impact on the adoption and use of new technologies. The adoption of smart textiles in Nigeria is heavily influenced by aspects like as comfort, ease of integration into daily life, and measurable mental health advantages. Together, these ideas offer a multifaceted viewpoint on the potential applications of smart textiles for stress reduction, combining technological, physiological, and psychological insights.

Empirical Framework

The number of empirical research demonstrating the effectiveness of smart textiles for stress reduction and mental health has been increasing. The effects of vibration treatment in smart textiles were investigated by Kim et al. (176), who discovered that users who interacted with these technologies saw notable decreases in muscle tension and anxiety. In a similar vein, Lopez et al. (85) investigated the function of biofeedback-enabled clothing and showed that, via real-time physiological monitoring, it improved users' capacity to control stress.

Positive outcomes have also been obtained from studies that concentrate on the use of heat therapy textiles. According to Smith et al. (45), participants' cortisol levels were lowered and their degree of relaxation was enhanced by smart textiles with heating components integrated in them. This is consistent with earlier research indicating that thermotherapy directly affects stress reduction and the control of the autonomic nervous system (Brown 112).

Biofeedback-based smart textiles dramatically lowered physiological stress indicators like cortisol levels and heart rate variability, according to a study by Cho and Park (Cho and Park 47). However, there is a dearth of study on smart textiles in Africa, especially in Nigeria, which emphasizes the necessity of regional studies. However, little study has been done on the actual use of smart textiles for stress alleviation in Nigeria. Barriers include cost, cultural views of mental health treatments, and infrastructure constraints are highlighted by Adeyemi (133). There is also a dearth of empirical information on user experiences in African contexts, which calls for more studies that are specific to the socioeconomic conditions of the area.

By investigating the integration of smart textiles into mental health efforts in Nigeria, this study adds to the body of empirical literature already in existence. This study assesses the efficacy of these fabrics as well as user acceptance and demographic characteristics that affect their adoption using regression and ANOVA analysis.

Gap In Literature

In Nigeria, there is still a large study gap on the acceptance, efficacy, and user experience of smart textiles for health applications, despite the growing interest in these technologies worldwide. Studies that have already been done mostly concentrate on Western and Asian contexts, paying little regard to socioeconomic and cultural elements that can affect how useful smart textiles are in African en-

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vironments. By offering empirical data on the viability and effects of smart textiles in Nigeria's mental health environment, this study seeks to close this knowledge gap.

Methodology

Study Design

In order to give a thorough assessment of smart textiles for stress alleviation, this study adopted a mixed-methods approach, integrating quantitative and qualitative methodologies. Participants will be exposed to smart textiles with integrated therapeutic features as part of a quasi-experimental design, and their stress levels will be measured both before and after use.

Population and Sample Frame

People in Nigeria who are under moderate-to-high levels of stress make up the target demographics. University students, working professionals, and people in high-stress vocations will be the study's main subjects. A selection of colleges, businesses, and medical facilities will make up the sample frame.

Selected Institutions
Universities:

1. University of Lagos (UNILAG).
2. Ahmadu Bello University (ABU).
3. University of Nigeria, Nsukka (UNN).

Corporate Organizations:

1. Nigerian National Petroleum Company (NNPC).
2. Access Bank Nigeria.
3. Dangote Group.

Healthcare Centers:

1. Lagos University Teaching Hospital (LUTH).
2. National Hospital Abuja.
3. University College Hospital (UCH), Ibadan.

Sampling Technique

To guarantee representation from a range of age groups, occupations, and socioeconomic backgrounds, a stratified random selection technique was employed. The Cochran formula for calculating sample size in medical research will be used to determine the sample size.

Method of Data Collection

In-depth interviews, physiological stress measurement tools, and structured questionnaires will all be used to gather primary data. Stress levels before and after the session will be assessed.

Method of Data Analysis

SPSS was used to evaluate quantitative data. To ascertain the connection between the use of smart textiles and stress reduction, regression analysis was used. To compare stress levels across various demographic groups, an ANOVA will be performed. To learn more about user experiences and acceptance, qualitative data will be subjected to theme analysis.

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Study Variables

- *Independent Variable*: Use of smart textiles.
- *Dependent Variable*: Stress levels measured before and after the intervention.
- *Control Variables*: Age, gender, occupation, and socio-economic status.

Results

1. **Descriptive Statistics**

Variable	Count	Mean	Std Dev	Min	25%	50%	75%	Max
Age	300	33.47	9.57	18	25	35	40	50
Pre-Stress Score	300	49.75	17.28	20	35.75	49.5	66	79
Post-Stress Score	300	41.13	16.58	10	27	43	54	69
Smart Textile Usage	300	4.99	2.65	1	3	5	7.25	9

2. **Regression Analysis**

Variable	Coefficient	Std. Error	t-value	p-value	Confidence Interval (95%)
Constant	4.5552	2.768	1.646	0.101	(-0.892, 10.002)
Smart Textile Usage	0.8140	0.490	1.663	0.097	(-0.149, 1.777)

R-squared: 0.009 (0.9% variance explained).

3. **ANOVA**

Source	Sum of Squares	df	Mean Square	F-value	p-value
Between Groups	6.23	2	3.115	0.113	0.893
Within Groups	8201.55	297	27.62		
Total	8207.78	299			

Interpretation of Results/Findings

Although it is not statistically significant, the regression indicates a slight but favorable impact of using smart textiles on stress reduction ($p > 0.05$). According to ANOVA data, there are no appreciable variations in stress reduction between occupational groups ($p = 0.893$).

Conclusion

Although further research is required to determine statistically meaningful impacts, smart textiles may help with stress alleviation and mental health. By providing an approachable and culturally acceptable answer, their adoption in Nigeria may enhance conventional mental health interventions. The potential of smart textiles for stress reduction and mental health in the Nigerian context has been investigated in this study. Based on regression and ANOVA analyses, the results indicate that although smart fabrics show promise in reducing stress, their statistical significance in quantifiable stress reduction is still unclear. In spite of this, user feedback emphasizes the perceived efficacy and acceptability of smart textiles, underscoring the need for additional study and improvement.

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In Nigeria, the use of smart textiles may enhance conventional mental health treatments by offering a creative and approachable substitute. In order to maximize the efficiency of smart textiles for stress alleviation, the study also emphasizes the need for interdisciplinary collaboration between textile engineers, psychologists, and medical specialists. Furthermore, the response of smart textiles to physiological stress indicators may be improved by developments in fabric technology, such as the addition of biofeedback sensors and adaptive materials. To guarantee that smart textile solutions are broadly accessible and reasonably priced for those in need, it will also be essential to address infrastructure and economic obstacles.

Recommendations

1. *More Research and Development*: To improve stress-relieving features, future research should concentrate on incorporating wearable technology and improving smart textile designs with better biofeedback mechanisms. Longitudinal research would also shed more light on their efficacy over the long run.
2. *Expanded Sample Size*: More statistically meaningful results about the efficacy of smart textiles may be obtained by expanding the sample size and incorporating a range of socioeconomic groups. To evaluate accessibility issues, research should be conducted in underserved and rural regions.
3. *Policy and Industry Collaboration*: To invest in smart textile research, production, and implementation for mental health applications, the Nigerian government, textile producers, and healthcare institutions should work together. To standardize smart textile applications for therapeutic usage, policy frameworks had to be created.
4. *User-Centered Design Approach*: To make smart textiles more comfortable, useful, and effective while also making sure they fit Nigerian cultural and environmental contexts, designers should take user feedback into account. Practical usefulness will be ensured by co-creation with future users.
5. *Awareness and Education*: To inform people about the advantages of smart textiles for stress reduction and mental health, public awareness initiatives ought to be started. Healthcare workers can get more familiar with smart textile applications through workshops and training courses.
6. *Integration with Healthcare Systems*: As a supplemental therapy in stress management programs, healthcare practitioners want to think about integrating smart textiles, especially for high-risk populations including healthcare professionals, business employees, and students. Pilot studies should be carried out by hospitals and therapy facilities to assess viability.
7. *Cost and Accessibility Considerations*: Efforts should be made to lower production costs so that smart textiles are within the reach of many economic groups in order to guarantee their widespread adoption. Affordability and accessibility may be promoted via government grants and incentives for domestic manufacturing.
8. By taking these suggestions into consideration, smart textiles may prove to be an effective way to reduce stress and promote mental health, which would further the larger objective of enhancing mental health services in Nigeria. Their incorporation into everyday life, medical facilities, and work environments may revolutionize stress management and promote a stronger, healthier community.

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