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REVIEW ARTICLE

Overview of intelligent clothing and accessories technology system for the disabled

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ABSTRACT

The purpose of this paper is to explore the application of intelligent technology in the industry of the disabled. Through the systematic review of databases (Redib, Doaj, Redalyc, BMJ, BVS, Dialnet and PubMed), 11 articles were obtained, describing the intelligent technology in ves-tiles devices, which are designed to help patients recover. In an interdisciplinary field, especially in the field of social sciences, there is a new and underutilized phenomenon. This review shows that further research is needed to expand this topic.

Keywords: disability; clothing; smart clothing and accessories; technology

1. Introduction

From the perspective of sociology, clothing (clothing and accessories) is an inherent part of people's life and plays a role of protection and display in daily life[1]. In addition, it uses psycho social factors related to body image to solve the problem of personal self realization[2].

But what happens when "dressing" happens in the field of disability?

Division occurs. On the one hand, an industry does not seem to know the needs, needs and expectations of a social group (those with specific preferences). On the other hand, "transparent" consumers try to adapt in some way to the clothes and shopping baskets created for the "other", and "different" bodies encounter obstacles in choosing what to wear[3].

In addition, in this case, the focus of fashion design is on functional issues, limiting needs and expectations you will strictly follow the medical model compared with most people. It is clear and not overlooked that disability significantly affects the body in several ways. Therefore, it is difficult to wear different clothes when creating services for such a diverse group[4].

At the same time, disabled bodies cannot be considered synonymous with barriers and lack of economic benefits[5]. People have interests, demands and rights to participate in the environment independent of their physical, physical and sensory conditions[6]. There, clothing and accessories play an individual's social performance function through three analytical variables (functionality, usability

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and aesthetics)[7].

In this way, technology appears in this social problem and provides different solutions for those who seek to dress/undress independently; help select clothing and accessories; communication and interaction with the environment. As Mann[8] named "visible computing" to understand functionality, comfort, aesthetics, sitting opposite conditions, mainly equal opportunities. In his article, the author defines "wearable" as an object that interacts and moves with users, and covers clothes through intelligent devices.

For Lobo et al.[9], this is a new design method, which combines information from different types of fields (engineering, biology, medicine, computer science, etc.) With different needs and expectations of users. The author describes three kinds of smart clothing:

(1) Clothing and its adjustment function, opening and closing;

(2) Portable apolipo protein i devices, such as orthosis, exoskeleton, etc;

(3) Portable intelligent devices, including sensors, nanotechnology, etc.

Especially in the medical field, Dittmar et al.[10] proposed the concept of healthy smart clothing, which refers to clothing that provides the possibility of using sensors to ensure that the treatment is non-invasive. For example, hair bands, T-shirts, socks, belts, shoes and other items made for rehabilitation purposes. In this case, it is important to emphasize the size and comfort of these clothes, as well as some related factors different from other clothes. Smart clothing is full of elements of speed, complexity, miniaturization, communication and new materials, which make small devices become active, low power, wireless or micro invasive devices. Smart clothing or accessories combine flexibility with functionality and use new fibers with specific properties (mechanical, electrical and optical).

In order to give full play to the relevance of intelligent technology in clothing, design must be user centered. Its goal is to identify real products and services according to people's needs, emphasizing not only practicality, but also the subjectivity of strippers[11]. For pullin, the design should also consider persons with disabilities and should focus on social models to change the environment. For example, glasses are for medical needs and have successfully become fashion accessories.

In the field of clothing, intelligent technology involves a mixture of electronic textiles, biometric materials, sensors and nano systems to resolve different health problems, reauthorize and daily activities without neglecting the aesthetic value[12]. The so-called "Smart clothing" created for the purpose of health monitoring, also use the intelligence system to generate interaction between the individual and his or her environment[13].

It is worth noting that the concept of intelligent technology is broad, and its richness is related to its application in medicine, engineering, psychology and other sciences, which use supporting standards according to the expected functions. It emphasizes the integration of basic skills into a coherent, low complexity and low cost system; guidelines for use in design involving interdisciplinary knowledge[14].

Particularly, dealing with intelligent design in clothing means moving towards a redefined system, combining tradition with clothing innovation. There, technology is positioned as a means of enhancing product potential in social change[15].

In this sense, the purpose of this work is to expand Argentina's knowledge in the field of fashion and social research on disability to a new theme. Detailed research, extracting relevant information, analyzing the quality of these studies and combining the main findings are the means to highlight relevant themes and trigger new directions in the psycho social aspects of fashion/disability.

2. Target

Within this field of analysis, the objective of this article is to systematically review the research that addresses the use of intelligent technology in clothing and accessories for people with disabilities.

3. Method

The premise of this systematic review is that the use of intelligent technology in the field of fashion design has a positive impact on the activities of daily life of persons with disabilities. To do this, research has focused on scientific articles that discuss the application of this technology in clothing and accessories designed to improve transparency, based on the recommendations of the prism declaration.

In this way, the following were included: Title, in which the publication was identified as a systematic review; (1) the structured summary; (2) the justification and objectives, where the knowledge of the subject and the implicit questions guiding the study were expressed (3 and 4); the method, with the eligibility criteria, the sources of information, search, selection, the data collection process and the variables for the data search (6 to 11); the results, with the selection and characteristics of the studies (17 and 18); the discussion, which presents the summary of the evidence, including the findings and the strength of the evidence of each study, limitations, conclusions, collaboration and financing (23 to 27). However, some items were excluded: protocol and registry; (5) the effects of assessing the risk of bias in individual studies; (12) summary measures; (13) the processes of synthesizing results, processing data, and combining results; (14) the risks of bias between studies (15 to 18 and 20 to 22); and the risk of bias in studies (19).

The search date focuses on English publications from January 2014 to July 2020. Considering that this topic has only recently appeared in Argentina, most publications are published in other countries, mainly the united states and the United Kingdom[16]. Articles in Spanish and Portuguese also have English abstracts. Therefore, the search is term centric: Smart clothes; disability and smart clothing.

The first searches were carried out in the following databases: REDIB-Red Iberoamericana de Innovación y Conocimiento Científico, DOAJ-Directorio de revistas de acceso abierto, Redalyc Red de Revistas Científicas de América Latina y el Caribe, España y Portugal, BMJ-open, BVS-Biblioteca Virtual en Salud, Dialnet and PubMed.

As a first search without specific filters and according to the descriptor smart clothing, a total of 763 articles were reached. Excluded were those in the areas of technologies related to architecture, education, accessibility, learning; in addition to general studies and literature review articles, congress and conference proceedings and those without empirical results.

Subsequently, smart clothing and disability reached 42 studies and the searches focused on the databases: BMJ-open, BVS-Virtual Health Library, PubMed. The justification is related to the objective of this study to analyze the applications of smart technology in clothing and accessories designed for people with disabilities. Thus, the studies relevant to this research are concentrated in these databases. Through the articles investigated, another descriptor used by the authors can be observed: Wearables in the databases: BMJ-open, BVS-Virtual Health Library, PubMed. With the purpose of expanding the amount of information, a third data exploration was made, with the terms: Smart clothing and wearables and disability. The search resulted in 14 investigations. Discarding duplicates and search restrictions, a total of 11 articles were found. This review was conducted between January 01, 2014 and July 24, 2020.

4. Results

The articles analyzed in this study prove the relevance of technology in fashion design, which aims to solve various problems related to disability in people's life, help nurses and increase independ-

ent life. At the same time, these studies show that the development and use of technology is still new and is beginning to gain great significance in the field of rehabilitation.

From the selected records, we analyzed 11 articles, which determined that this work involves user centered design, and intelligent technology is a tool that can express sa in targeted clothing and accessories to actively supplement the health of patients.

The study describes the forms of portable technology: Shoes, insoles and gloves. They are adaptive and pony accessories that enable people to carry out rehabilitation activities more autonomously and improve independence. Some studies have revealed changes in the doctor patient relationship after the use of technology[17]. For example, use smart shoes to capture the autonomous walking parameters of patients with els (lumbar spinal stenosis); after surgery, it not only helps to accurately measure its functional level[18], because it produces economic and rapid effects in clinical information analysis[19]. In addition, gloves can replicate movement patterns and help restore weak hands[20]. In addition, intelligent insole is very important for the prevention of foot ulcer in diabetic patients. In this context, technology has become a progressive tool to prevent patients from dying in more severe disease stages[21].

These studies explore the possibility of functional and aesthetic design, as well as the possibility of social design, in which advances in science and technology can provide solutions through intelligence to enable persons with disabilities to meet their daily activities[17].

Without leaving aside the concern with consumption and how people observe the use of technology in their daily lives. The advantages and disadvantages, and to what extent it is a benefit for the family in relation to the care of people with disabilities, once technology generates independence and quality of life[22]. There are still many questions to be answered.

The methods used in the study describe: Qualitative and quantitative research with focus groups; prospective research, design feasibility assessment, experimental research and scope review, using qualitative and quantitative methods.

Reviewing each article, you will find that Hall et al.[22] in consumer behavior, they analyzed the impact of using smart clothing from the perspective of disabled caregivers and family members. According to the focus group interview, the results obtained by the author show that the adoption of technology in clothing involves various factors and environment (in terms of the role, rules and limitations of the technology system). It is essential that both consumers and caregivers receive adequate information. In addition, there is widespread concern about the use of smart clothing in caregiver recipient relationships, where personal interaction can be replaced by technology. However, the study did not rule out the benefits of freedom and control because it reduced some nursing tasks. On the other hand, there are benefits when patients use relevant information.

Ma et al.[23] found that in recent years, research on glove virtual experience development for hand movement and strength has increased. In this sense, this study proposes a hand rehabilitation learning system, namely safety gloves, a device that can learn the interesting movement of grasping and releasing objects. The author collects information from the data of people without such difficulties. The results show that the prototype not only provides information for learners, but also provides greater autonomy for the disabled in grasping and releasing objects.

Starting from the concept of wearable technology, Papi et al.[17] described the development of small electronic devices and accessories for clinical and rehabilitation purposes. They studied user centered design and the development of portable technology to monitor the functional status of knee joints in patients with osteoarthritis. As a result, it was found that many of the technologies developed did

not consider the preferences of patients and health professionals, thus hindering more active use. However, few studies have explored this issue. At the same time, through the interview, the results show that all 21 participants believe that the product must be small, have the least interference to daily life activities, and be easy to use.

In order to gain a deeper understanding of the phenomena studied, Papi et al.[19] do a second investigation, in this case focusing on the preferences of healthcare professionals, as a means of identifying implementation strategies in the development of wearable technology more realistic to patients' needs, according to progress, treatment assessment and compliance monitoring. This is also a means to generate information related to clinical decision making. Through interviews with 4 clinicians, 4 physiotherapists and 5 orthopedic surgeons, the authors arrive at findings that support the use of wearable technologies to improve the current management of osteoarthritis, where efficacy is directly linked to the development of products that combine locomotion capability with ease of use and interface. The study presents that the potential use of wearable technology in the treatment of osteoarthritis is related to: The usefulness of the technology in clinical practice; the provision of patient data, time management, patient compliance in use, information properties, product specificity and the relationship of the professional with the patient.

Biggar and Yao[20] describe exoskeletons as one of the ways to improve the mobility of people with disabilities (stroke patients). In this case, the author uses virtual reality theory, through a system, with the development of patients at home, it has greater practicability and lower operation cost and space; by developing the intelligent prototype described in the glove, individuals can exercise their fingers more flexibly.

In order to quantify the functional level of walking ability of esl patients, Li et al.[24] independently developed an intelligent calibration design based on two algorithms according to oswestry preoperative and postoperative disability index scores. The collected results show that the use of shoes with sensors is not only helpful for treatment and nursing, but also helpful to obtain more effective clinical information to understand the functional level of patients in surgical treatment.

Biggar et al.[25] described the positive impact of intel technology on health, mainly in the field of persons with disabilities, where people face a series of obstacles that hinder more social participation. In order to change the health and environment, the authors believe that it is necessary to quantify the needs of end users, because they can determine whether the prototype design is beyond its therapeutic purpose, functional, comfortable and aesthetic. Based on these meanings, the study was based on a questionnaire of the QFD-Quality Function Deployment method, based on the variables: Joint movement, function, control, usability and a combination of remaining aesthetic and practical characteristics. From there, the objective was to collect information from patients with the purpose of arriving at a low-cost device that could be used at home, as an assistive tool and as a therapeutic aid. Also to generate information for therapeutic decision making[25].

According to the background used in the study, Lee et al.[18] observers found that about 33% of patients with esl were not satisfied with the clinical results after operation. This is due to pain and lack of function at the bottom. Therefore, they studied the use of technology in apparel design by evaluating a pair of smart shoes with five insole pressure sensors in preoperative ESL patients. The results indicate that smart shoes are a noninvasive, easy-to-use, and cost-effective treatment. In addition, it provides a complete analysis of the walking tests, which makes possible an evaluation with comparisons during the postoperative period.

Esmail et al.[26] described the use of clothing technology for persons with disabilities based on a comprehensive literature review and expert consultation. They believe that the design of smart clothing

includes not only social and cultural functions, but also the need to collect enough information in the field of rehabilitation, so as to find solutions or methods to help these people live independently. The authors emphasize that there is little literature, which creates uncertainty and requires further research to promote social inclusion and participation.

Hatton et al.[27] studied the use of textured insoles in patients with diabetic peripheral neuropathy within 4 weeks to analyze walking performance and possible balance disorders. In this study, the researchers noted that the effect of traditional footwear on balance function in patients with diabetic peripheral neuropathy has not been widely studied. In this way, this work involves the development of smart shoes to improve the sensory environment of the foot as a viable option to help supplement the treatment of balance and walking problems in patients with diabetes, Parkinson's disease, multiple sclerosis, etc. Different prospective studies were conducted in a parallel group of 70 diabetic patients. The subjects were randomly divided into texture template group (intervention group) and smooth template group (control group). The results show the importance of the product to health and its relationship with user needs and key functions, such as the comfort and beauty of the product.

The review concludes with the work of Ming et al.[21] who describe smart technology as a preventive tool. The objective was to evaluate temperature controls and to be able to make timely and appropriate interventions for foot problems in people with diabetes over a 2-year period. The authors administered a control of slipper use with sensor insoles and the Smart Prevent Diabetic Feet application in 300 participants. The results achieved contributed to timely monitoring and intervention. It was also possible to build predictive models from the information collected by the sensor.

5. Discussion

This systematic review highlights a new topic in the field of disability and the social research of fashion design. It is worth noting that intelligent technology has begun the first step of building applied knowledge, which combines different disciplines such as computer science, medicine, rehabilitation, psychology, marketing, sociology and engineering to create thinking products that meet different needs and expectations.

These 11 articles (**Table 1**) show that the combination of clothing and technology goes beyond print and accessories designed for daily social interaction. With the increase of human needs and demands, the main function of protecting the body is open to other needs. Based on this view, most studies emphasize the relevance of people's participation in research. In product and service development, user centered design is an effective method of technology configuration and collaborative training.

It is worth noting that the use of intelligent technology still seems to be limited to the medical field and different rehabilitation needs. This has attracted people's attention because it shows that in all the progress of disability research, this phenomenon is bound by the medical model, ignoring people's strong demand beyond its limitations.

Faced with this, this systematic study questions the application of technology in disability. He pointed out that the analysis of the ways and purposes (advantages and disadvantages) of using smart clothing and accessories seems to be limited to one area. Although the role of rehabilitation is very important to the daily life of this social group, the increase of many technical equipment is crucial to the quality of life. However, we cannot ignore the demand for intelligent technology, which should not only improve users' skills, but also meet different tasks and promote greater social participation.

In addition, considering the different needs of persons with disabilities, it is difficult to understand how actively involved the fashion design process is. More systematic observation may be a more beneficial option. Therefore, those who produce intelligent objects should not be limited to the sensitivity

of rehabilitation equipment, but should open up new ways of products and services for a more independent life.

Table 1. 11 articles

Author/Year	Method/Instrument	Population	Results	Knowledge domain
Hall et al. (2014)	32 participants (8 in each of the four focus groups) teachers and graduate students, administrators and students of midwestern universities in the united states.	Exploratory research based on focus group method for data collection and focus group interview	Wearable technology can be used to promote a healthier relationship between caregivers and people with disabilities, as well as surgery for people with disabilities.	Family and consumer science
Ma et al. (2015)	Experimental design. Safety Glove system	Twelve volunteers aged 20 to 69 had normal function and no pain in their hands.	The development of safety gloves is a new way to understand the learning system in the process of rehabilitation. In addition, it allows data to be collected for decision making.	Electrical engineering
Papi et al. (2015)	Focus group study; data management was carried out through thematic analysis of patient response.	21 cases of osteoarthritis	Patients' views on the development of intelligent accessories technology are related to understanding the fun, comfort and aesthetics of rehabilitation treatment.	Surgery and cancer
Papi et al (2016)	Quasi static research using inductive thematic analysis	13 health specialty	Transplantation technology improves the relationship with patients. Planned use helps manage time and decisions.	Surgery and cancer
Yao ming (2016)	Patients with cerebrovascular disease	Design and development of prototype	Design a nursing facility with strong adaptability and easy management for patients, so that they can carry out rehabilitation activities at home, reduce the workload of therapists and increase their dependence on nursing staff.	Biomedical engineering
Li et al. (2016)	An automatic rhythmic learning je was designed to estimate oswestry's disability index.	29 cases (11 males and 18 females) with LSS (lumbar spinal stenosis).	Application of za pato intelligent analyzer in surgical treatment of patients with esl	Physical medicine and rehabilitation, computer science and neurosurgery
Biggar et al. (2017)	Five-point questionnaire	13 cases of orthopedic rehabilitation	The information collected from patient information is a decisive factor in product development, both functionally and from comfortable.	Biomechanics and bioengineering in orthopedics and cardiovascular rehabilitation
Lee et al. (2017)	Analysis of parameters according to the Oswestry Disability Index (ODI) and the Visual Analog Scale (VAS).	Twenty-nine males and eight females were treated with ESL.	The use of smart shoes can accurately predict the surgical results of patients by optimizing treatment strategies.	Computer science, neurosurgery and neuromotor rehabilitation
Esmel, e t in los angeles. (2018)	The iterative analysis of the literature was reviewed and cooperated with the expert advisory group.	12 experts (experts in the fields of health, design, industrial manufacturing, health technology, rehabilitation and psychology (6 researchers, 3 representatives of the fashion industry (new technology, design, enterprise development and innovation), 2 postdoctors in rehabilitation medicine and 1 patient with spinal cord injury).	The research on intelligent fashion design information system is a means to create knowledge and improve the participation of the disabled in society.	Psychology and reauthorization

Hatton et al. (2019)	Randomized controlled trial, prospective vo, single blind parallel grouping.	70 cases of adult diabetic convulsive neuropathy.	The intelligent shoe device manually operates the non sensory internal environment of the foot through the insole, which is a choice to eliminate the balance and gait problems of nervous people.	Health and rehabilitation science
Ming et al. (2019)	Open label, prospective, alloy crimp, 24 months	300 patients with diabetes mellitus (type 1 or 2) and severe diabetic peripheral neuropathy	Using portable and intelligent devices to measure temperature is a good choice and helps to provide appropriate interventions for health care providers.	Kidney disease and hypertension, diabetes and endocrine.

It must be clarified that this issue is not intended to cover the multidisciplinary work of the submitted studies, because these studies serve as a reference and provide product opportunities for the rehabilitation, health maintenance, functional rehabilitation and improvement of the quality of life of persons with disabilities. In addition, research has shown that finding solutions from sensors, nanotechnology and new textiles can change the social, psychological and environmental barriers of disability.

This systematic review has created a space for scientific research on the use of disability, from clothing to intelligent technology. Therefore, the preciseness of methodology makes people realize that this is not a simple way to ask for help. It is necessary to understand new concepts, methods, comparisons and cognitive limitations, so as to make progress in the scientific field of the proposed phenomenon.

Conflict of interest

The author declares no conflict of interest.

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