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DEVELOPING ADAPTIVE BRA DESIGN FOR WOMAN WITH HEMIPLEGIA: A LITERATURE REVIEW

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ABSTRACT

Female stroke patients with hemiplegia will experience difficulties to not be able to use bras independently are due to weakness in the upper extremities. Meanwhile, the use of bras is very important for women because bras have a major function in maintaining breast shape by lifting the breasts. Therefore, this study aims to review developing adaptive bra design for woman with hemiplegia. The method of this study was a literature review. After screening stages, two studies are included in this review. Adaptive bra design for woman with hemiplegia is the development of a bra with modifications of material, design, and additional features, especially in the fasteners section by paying attention to good and comfortable materials for users. Some additional features can also be used either to monitor the physiological body of the user or in order to assist the use of the bra. A good adaptive bra design is a design that can help wear and remove the bra with one hand while still paying attention to comfort and aesthetic value.

KEYWORDS : *Apparel technology, magnetic fasteners, monitoring system, stroke, underwear*.

INTRODUCTION

Stroke is a neurological disorder associated with blood vessel blockade. Clots that form in the blood vessels of the brain will disrupt cerebral blood flow resulting in rupture of the blood vessels and bleeding. This rupture will also result in a lack of oxygen intake to the brain and result in brain cell death (Kuriakose and Xiao, 2020). Data from the Global Stroke Fact Sheet 2022 shows that 56% of stroke patients in the world today are women, which means that even more than half of the number of stroke events occur in women (World Stroke Organization (WSO), 2022). Based on the 2018 Riskesdas data, the average prevalence of stroke in Indonesia reached 10,082 per mile (Balgis, Sumardiyono and Handayani, 2022).

Stroke patients may experience functional impairment, ranging from motor, sensory, cognitive, perceptual, or language impairment. In particular, more than 85% of stroke patients who experience paralysis on one side of the body experience impaired upper limb function and reduced mobility and this is one of the main factors for stroke patients experiencing interference in carrying out activities in daily life (Lee, Choi and Jeoung, 2022). Stroke patients will experience difficulties, from eating activities to dressing so that this causes many stroke patients to ask for help from others in dressing, one of which is when using a bra (Everard *et al.*, 2022). The things that cause stroke patients to not be able to use bras independently are due to weakness in the upper extremities, especially in the scapula and shoulders. In the scapula, patients have not been able to perform optimal retraction and downward rotation of the scapula. Meanwhile, in the shoulder, the patient feels pain, especially when performing abduction and internal rotation movements. The patient is also not optimal in performing grasp and pinch movements or movements that are usually done when grasping an item (Hidayati, Pratiwi and Aliya, 2018).

Meanwhile, the use of bras is very important for women because bras have a major function in maintaining breast shape by lifting the breasts so as to reduce breast ptosis. Bra wearing also affects self-confidence in dressing in women (Imran *et al.*, 2021). The reduced independence of female stroke patients in wearing bras can cause fatigue and frustration because of the feeling of having to depend on others. Therefore, wearing a bra on female stroke patients not only affects physically, but also

affects social and psychological aspects.

Various solutions are carried out to facilitate the wearing of bras for female stroke patients. Research from Hidayati (2018) is a study that uses the Bobath concept, which is a concept that focuses on improving postural movement as an occupational therapy intervention in improving bra-wearing ability activities (Hidayati, Pratiwi and Aliya, 2018). In addition, the development of bra shapes has also been carried out in Susilawati's research (2019) to increase the confidence of post-mastectomy breast cancer patients (Susilawati, 2019). However, the development of the bra itself to improve the ability to wear bras independently for female stroke patients is also one of the solutions that can be developed. Therefore, this study aims to review developing adaptive bra design for woman with hemiplegia.

MATERIALS AND METHODS

The method of this study was a literature review.

Eligibility Criteria

The inclusion criteria for this study were: abstract and full text available, the population was woman stroke patient with hemiplegia, intervention using adaptive bra, and outcomes were evaluated from users after using adaptive bra. The exclusion criteria for this study were: study conducted before 2015 and language other than English and Indonesian.

Search Strategy

The authors obtained published studies from four major databases: PubMed, Cochrane, Online Wiley Library, and Google Scholar. The keyword used was using Boolean operator. Keywords used in each database is "Development OR Developing AND Adaptive AND Dressing OR Clothing AND Design AND Bra OR Beha OR Bandeau OR Brassiere OR Underwear AND Woman OR Women OR Female AND Stroke AND Hemiplegia OR Hemiparesis OR Hemiplegic OR Hemiparetic".

Selection Process

Authors conducted two stages of the screening process using Mendeley Desktop Version 1.19.8. Before conducting the two screening stages, they independently removed duplicate studies using Mendeley Desktop. For the first stage, they independently screened titles and abstracts. They categorized them into "Include," "Exclude," and "Maybe" based on the year of publication, language, complete abstract, study method, relevant population, intervention, comparison, and outcome. In the second stage, they independently screened the full text of studies included in the "Include" and "Exclude" categories based on relevant population, intervention, comparison, and outcome.

Data Collection Process

Authors simultaneously developed a custom data extraction form and extracted the relevant data, and recorded it in Google Spreadsheet. The recorded data were (1) first author, year, (2) study location, (3) description of population, (4) material of intervention, (5) design of intervention, (6) additional features of intervention, and (7) description of outcome.

RESULTS

Study Selection

We identified 600 records through databases searches. After screening stages, we included two studies in the literature review.

Study Characteristics

After screening and rechecking to maintain relevance to inclusion and exclusion criteria, two studies are included in this review. The details of included studies are shown in Table 1**.** All of the studies were published between 2015 - 2024. The total number of participants were 3 and interventions of all included studies were adaptive bra for woman with hemiplegia.

Table 1. Study Characteristics

Author, Year	Study Location	Population	Intervention			Outcome
			Material	Design	Additional Features	
(Imran *et al.*, 2021)	France	• 3 women suffering from hemiplegia as users • 15 women from university administrative staff and students as evaluators	• Bi-layer knitted fabrics • Magnetic for fasteners • Shape memory nitinol wires for the additional features • Flexible plastic material for plastic stays • Silicon adhesive	• In design A, magnetic fasteners were used at center front and on extended bra strap at the left side. Plastics stays were inserted at center-back. • In design B, magnetic fasteners were used at center front and on extended bra strap, they are attached with the extended bra strap. Plastics stays were inserted at center-back and silicon adhesive material was added under the shoulder level of shoulder straps. • In design C, the placement of	The additional features in this design is the bra can change their shape and super elasticity within the range of human body temperature.	Design C was the most preferred design that enables the hemiplegic females to fasten bra single-handedly and additional features smart material, which change their shapes and super elasticity within the range of human body temperature

Author, Year	Study Location	Population	Intervention			Outcome
			Material	Design	Additional Features	
				flexible magnetic fastener and shape of an extended bra strap is the same as in design B. Shape memory wires was inserted at center back.		
(Imran *et al.*, 2017)	France	No application in patient	• Magnetic for fasteners • Gold Nano-electrodes fabricated on a flexible substrate for the system monitors	Extended bra strap with front opening, magnetic fastener and the system monitors on the front side	E-bra (The system monitors blood pressure, body temperature, respiratory rate, oxygen consumption, some neural activity, and all the readings by a conventional electrocardiograph (ECG), including the ability to display inverted T waves, which indicate the onset of cardiac arrest.	Patients can wear bra independently and get information about any pathophysiological changes from the system monitoring

DISCUSSION

Material

Fabric material is one of the important things in bra development because it will affect the comfort aspect. Fabric materials that can provide comfort are fabrics that can absorb sweat, cool, and dry (Mccoy, 2021). The research from (Imran *et al.*, 2017) did not explain the use of specific fabrics in the adaptive design of the bra that they made, but the research (Imran *et al.*, 2021) used bi-layer knitted fabric as the main fabric material. The bi-layer knitted fabric is a fabric that is easy to dry and absorb sweat and this can be the key in providing comfort for the users. This bi layer knitted fabric also has a good function in maintaining body temperature. The inner layer of the fabric that is in direct contact with the skin will have a high thermal conductivity in order to help the heat transfer process to the outside layer of the fabric. Meanwhile, the outer layer of the fabric will be easier to absorb sweat so that sweat will later undergo an evaporation process to the environment (Udaya Krithika *et al.*, 2020).

Based on a survey conducted on female arthritis patients who have difficulty in wearing bras where this also happens to female stroke patients who have hemiplegia, especially when donning and doffing bras, it is recommended that several materials can be used in making bras for these arthritis patients. The bra hook materials include Velcro adhesive, large zippers, and hook and eye bras. These materials make putting on and taking off the bra easier to do especially by one hand. (Mccoy, 2021). Both designs in this study used magnetic materials as fasteners of the bra itself. The use of these magnetic materials can reduce the strength, mobility and sensitivity of their hands when attaching the fasteners. The position of the fasteners also affects the wearing and removal of the bra, the position of the fasteners placed at the front will facilitate the donning and doffing of the bra with one hand (Imran *et al.*, 2017).

Both adaptive bra designs in this study also have additional features that certainly require additional materials for making these features. Research (Imran *et al.*, 2017) uses gold Nano-electrodes which are small and flexible enough that they will be easily attached to the bra fabric and will not interfere with comfort or movement when wearing the bra. Meanwhile, research conducted by (Imran *et al.*, 2021) uses wires of nickel titanium-alloys where the use of this material is carried out in accordance with the expected function.

Design

The design that needs to be developed to make an adaptive bra for female stroke patients with hemiplegia certainly needs to pay attention to the ability to wear and remove the bra independently, comfort, and also still pay attention to aesthetic value. Research from (Imran *et al.*, 2021) developed three designs, design A where magnetic fasteners were used at center front and on extended bra strap at the left side. The use of this extended bra strap aims to provide more grip areas to fasten the front fastened bra with a single hand and there is the use of flexible plastic material to hold the back of the bra because when installing fasteners on the front, generally the back of the bra will move position if there is no holder. In general, design B almost has the same design as design A. However, in this design B is added silicon adhesive was added under the shoulder straps to avoid the slippage of the shoulder straps. In addition, the fasteners area is also given a different color so that users can easily recognize where the fasteners are located when pairing the bra. In design C, the location of fasteners and extended bra straps is still the same as design A and B, but the use of plastic material on the back of the bra is eliminated because the use of plastic material reduces the comfort and flexibility of the bra itself. Furthermore, in this design, the additional features began to be placed on the center back of the bra. After that, three users were evaluated and design C was the most chosen design because of the additional features which is an added value for this design (Imran *et al.*, 2021).

While the design developed in this study also shows similarities in the location of fasteners and the presence of extended bra straps, what is quite different is the shape of the monitoring system and its location at the center front of the bra, right at the straps (Imran *et al.*, 2017).

Additional Features

The additional feature developed in the first study is the monitoring system. The monitoring system developed by the research (Imran *et al.*, 2017) is a fairly complex monitoring system, where this monitoring system will monitor blood pressure, body temperature, respiratory rate, oxygen consumption, some neural activity, all the readings provided by a conventional electrocardiograph (ECG), including the ability to display inverted T waves, which indicate the onset of cardiac arrest. This is done in order to monitor any changes that occur in the body that lead to pathologies.

Meanwhile, the additional features developed by (Imran *et al.*, 2021) is a sensor where the panel can expand or contract in size to reach a certain size according to the user's body temperature. This will certainly help when putting on and taking off the bra. The wire length of the panel is 30 cm and can increase in length by 30%, which is 39 cm.

Outcome in Patients

Hemiplegia is one of the most common post-stroke complications. Hemiplegia will also interfere with the activity daily living (ADL) and quality of life of post-stroke patients. Disability experienced by stroke patients can occur for years (Huang *et al.*, 2016). Research (Crichton *et al.*, 2016) shows that only 33% post-stroke survivors can live independently, while the rest experience mild to severe disability. Meanwhile, in 15 years post-stroke survivors who can live independently only amounted to 36.8%. Most of these people also only received independent care at home, without nursing home or long-term hospital care.

Activities daily living (ADL) that can be disrupted are activities that must be done daily, such as eating, bathing, urinating, defecating, including dressing. This dressing activity also includes wearing underwear, such as bras. In fact, the bra serves to reduce back pain because the size of large breasts often causes pain or soreness in the back. To avoid the pain or soreness, often women will tend to bend their bodies forward. If this continues, it can affect posture which will turn into a hunchback. Using the right bra can lift your breasts so that your posture can be maintained (Hading, Abu and Nurhijrah, 2023). Research (Nurhidayat, Andarmoyo and Widiyati, 2021) shows that the majority of stroke patients experience total dependence in carrying out daily activities based on the Barthel index value, namely in 63% of ischemic stroke patients and 79% of hemorrhagic stroke patients. The majority of these patients cannot perform activities, such as dressing, cleaning themselves, bathing, using toilet facilities, moving from a wheelchair, walking on a level place, and going up and down stairs. These activities must be assisted or fulfilled by others.

Research (Imran *et al.*, 2021) provides results where patients can wear bras with one hand so of course this will increase independence in patients in wearing bras. This also shows the same thing as the purpose of bra development conducted by research (Imran et al., 2017). The main concern in the development of bras for female stroke patients with hemiplegia is independence in wearing and removing bras while still paying attention to comfort and aesthetic value (Imran *et al.*, 2021).

Strengths and Limitation

This is a first literature review that show developing adaptive bra design for female stroke patient with hemiplegia. But, this study has some limitations. The literature review only has few included studies because there is still a lack of previous research that discusses this topic. Study location of included studies only conducted in Frances. The total sample size of the included study is also considered low.

CONCLUSIONS

Adaptive bra design for woman with hemiplegia is the development of a bra with modifications especially in the fasteners section by paying attention to good and comfortable materials for users. Some additional features can also be used either to monitor the physiological body of the user or in order to assist the use of the bra. A good adaptive bra design is a design that can help wear and remove the bra with one hand while still paying attention to comfort and aesthetic value.

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Conflict of Interest

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