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Design of walking assistive device for children with cerebral palsy, Vestmiles

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Abstract
Celebral Palsy (CP) is a disorder of muscle control which results from some damage to part of the brain. Children with cerebral palsy can have problems such as muscle weakness, awkardness, slowness, shakiness, and difficulty with balance. In severe cerebral palsy, the child may have many difficulties in performing everyday tasks and movements. However, a proper treatment often brings an improvement, though not a cure. In terms of independent mobility particularly walking and standing, this study aims to design a walking assistive device called Vestmiles. The product design includes four parts: a belt, vest, sandals for parents, and sandals for children with the length and height successively: 47.3 cm and a 23 cm; 39.3 cm and 59 cm; 26.9 cm and 9.9 cm (parents' size of slippers); 23.9 cm and 6 cm (children's size of slippers). To design the product, it is used the measurement gained from 3 Celebral Palsy children. This work is not only to support physiotherapy program, but also increasing relationship between children and parents. Vestmiles is a user friendly, lightweight, adaptable, efficient and cost effective device.
Keywords: Walking assistive device, celebral palsy, vestmiles, physioterapy

1. Introduction

The brain controls all that what we do. Different parts of the brain control the movement of every muscle of the body. In celebral palsy, there is damage to, or lack of development in, one of these areas of the brain. Cerebral Palsy (CP) was first introduced by an orthopedics surgeon named William James Little in 1862. Celebral refers to the brain while palsy can mean weakness or paralysis or lack of muscle control. Therefore celebral palsy is a disorder of muscle control which results from some damage to part of the brain [1]. The term of celebral palsy is used when the problem has occured early in life to the developing brain. Many new treatments have become available over the past two decades. Treatment can be considered in three areas: (1) treatment of the movement; (2) treatment of the associated medical problems; and (3) provison of the therapy and early intevention services.

Related to the movement problem, paediatric therapists play a key role in the management of it. Physiotherapy is essential to provide a program to encourage motor development [1]. Physiotherapy helps restore movement and function when someone is affected by injury, illness, or disability. The health ministry of Indonesia has published regulation of physiotherapy number 80 of 2013. It discussed the general regulation, the certification, and the implementation of physiotherapy services. In accordance to the meaning of physiotherapy and the treatment of movement, this study focuses on designing an assistive device to be applied in physiotherapy for CP children.

Spastic cerebral palsy is the most common type of cerebral palsy. Spasticity means stiffness or tightness of muscles. Children with spastic cerebral palsy, both groups of musclesmay contract together , making the movement difficult. Assistive technology or assisstive devices are to help with mobility limitations associated with cerebral palsy (CP). Most assistive devices can be adjusted to fit a child's heigt or can be specially made to fit their individual needs [2]. Assistive devices greatly improve a child's quality of life, as well as increase their independence. A new walking aid with axillary support (WAAS) has been design by evaluating electromyograhy (EMG) activity of quadriceps, hamstrings, tribialis anterior, and gastrocnemius [3]. Six children with spastic diparesis due to CP had been asked to perform a straight line walking course in two situations: with or without using WAAS. The use of WAAS significantly increased the EMG activity of the quadriceps and hamstring during stance phase and tibialis

anterior swing phase, with no significant increase in gastrocnemius activation.

Walking aid effects are important for patients with GMFCS II-III (Gross Motor Function Classification System). Twenty six patients with spastic bilateral CP (GMFCS II-III) were assessed the influence of the use of forearm cruthes and posterior walker during walking. This influence will be set to outcome effects of surical intervention studies [4]. Treadmill is an instrument used for gait training and analysis. Comparing overground and treadmill walking in children with CP showed different perceived related to selected walking speeds [5]. Twenty children with CP performed for both walking methods. It was revealed that children with CP chose significantly slower speeds when asked to select their comfortable and fastest walking speeds on the treadmill as compared to overground. The short walking exercise on gait kinematics in children with cerebral palsy who walk with a crouch gait has given no significant difference between walking speed before and after the walking exercise [6].

Each material of walking assistive device design gives different wearable walking. Several assistive robotics review showed limitations related to the development of wearable walking assist devices [7]. One of the largest problems facing designers is the power supply. Steel, for example, is heavy and the device must work harder to overcome its own weight in order to assist the wearer, reducing efficiency. The aluminiums alloys used are lightweight, yet fail through fatigue quickly. Thus, it becomes challenging topics exist regarding the development of wearable walking assist devices.

In Yogyakarta, there are 7 public schools and more than 30 private schools for children with disabilities and special needs. Based on observation at one private school in Sleman, it provides a physiotherapy service for CP children conducted twice a week, on Mondays and Thursdays. Each meeting, the children will get the exercise for 1 up to 2 hours depending on their condition. There are swimming pool, paralel bar, treadmill, and walkway. Yet, several problems are occured such as lacking of motivation of the children joining the physiotherapy, lacking of information between parents and therapists, the service schedule is not optimized by doing only twice a week, and parents do not get a better information of each phase done during the physiotherapy. It is found that lacking of motivation caused by the effect of doing physiotherapy i.e pain. The children assessed did not feel comfortable and tended to refuse doing the theraphy. Lacking of physiotherapists has led to conduct the therapy twice a week [8]. Regarding to these results, this study aims to design a walking assistive device to support physiotherapy in school for children with CP. The device is useable and portable as well. It is also user friendly for parents. Thus, there are 2 pairs of slippers designed for both parents and children.

2. Research Method

It is a small group object assessed comprises 3 children with CP together with their parents. The respondents are studying at one of private school for children with disability and special needs in Sleman. There are 14 dimensions of children and 10 dimensions of parents measured. The data is tested statistically: sampling adequacy test, uniformity test, and normality test. Then, percentile test is applied to determined the percentile chosen for the calculation. It is used 95% percentile. The research framework can be seen in Figure 1 below.

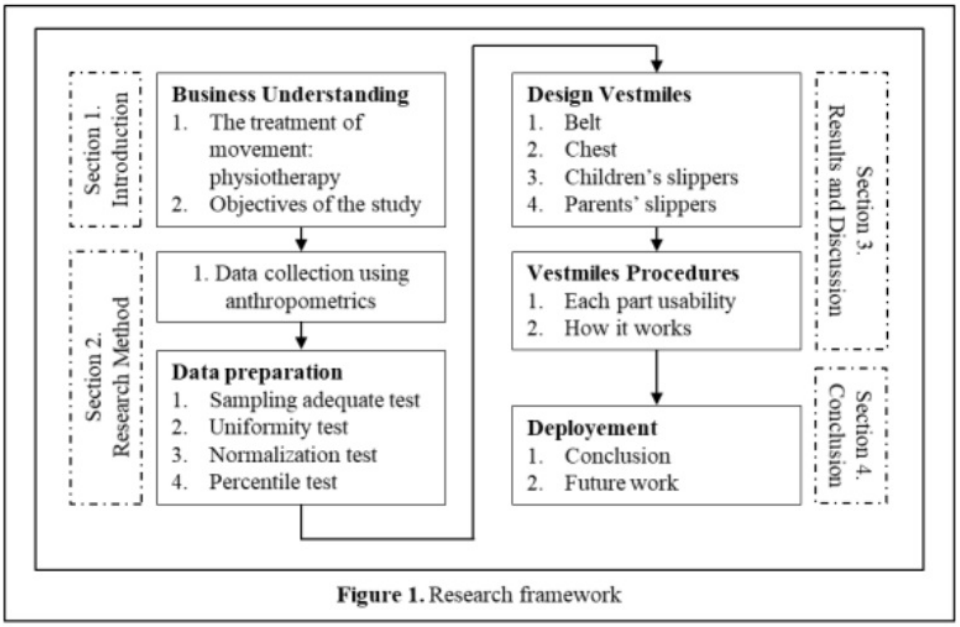

Figure 1. Research framework

3. Results and Discussion

The design comprises 4 parts: belt, vest, slipper for children, and slipper for parents. Each part measurement is showed in Figure 2, 3, and 4. Since the children with CP need to be assisted while walking and standing, the device design includes a belt for parents. While the slippers are put together. The idea is that the children will walk based on their parents' step. Parents help their children to stand and walk at the same time. It will be easy to handle the children as they are tighthened and connected to parents during the physiotherapy exercise.

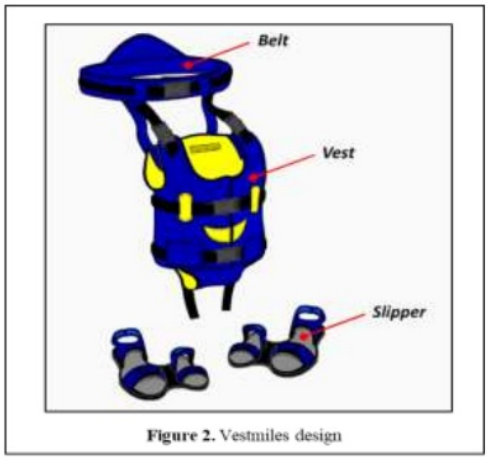

Figure 2. Vestmiles design

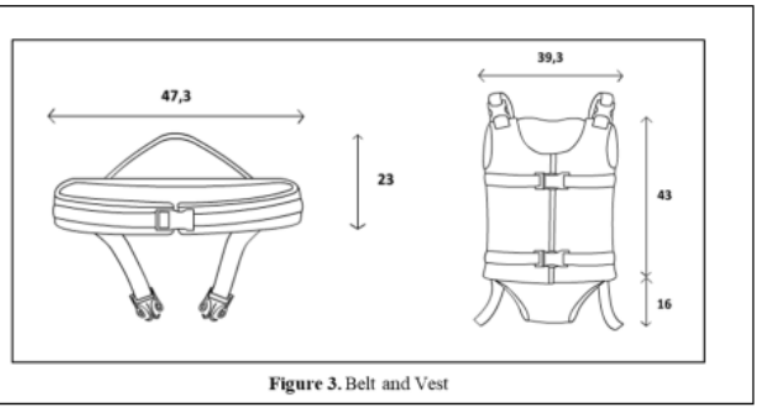

Figure 3. Belt and Vest

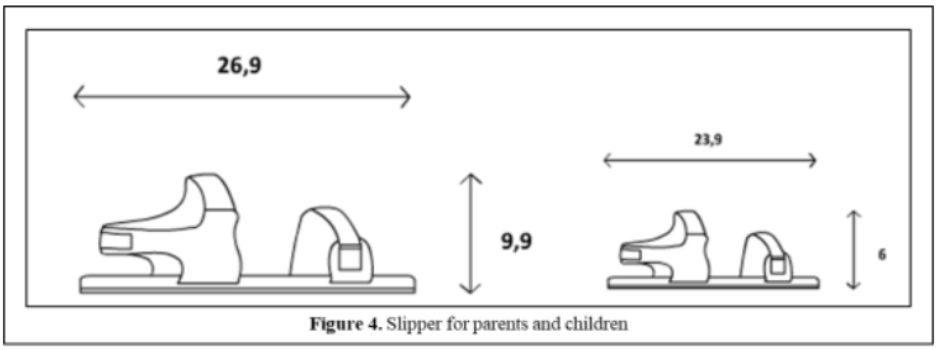

Figure 4. Slipper for parents and children

3.1 *Vestmiles usability*

The following are the usability of this walking assistive device:

- The main function is to support the physiotherapy process particularly walking and standing exercise. By using vestmiles, physiotherapy can be conducted more twice a week as it is easy to use.
- Another problem occured is lacking of physiotherapists. Vestmiles will put parents as an assitant during the physiotherapy exercise. This is not only to create the physical interaction between parents and children, but also leverage the emotional feeling between them. At the same time, the children can increase the motivation doing the therapy due to parents involved and participation.
- It is expected to be able to reduce muscle stiffness in the legs of children. The user friendly and portable design make the children become more active instead of sitting on a wheelchair.

3.2 *Vestmiles procedures*

It is a simple way to use by tightening the belt to parents' waist, the vest is for the children's body, and the slipperS put on to children's and parents' legs. How the device works is explained in the following Figure 5.

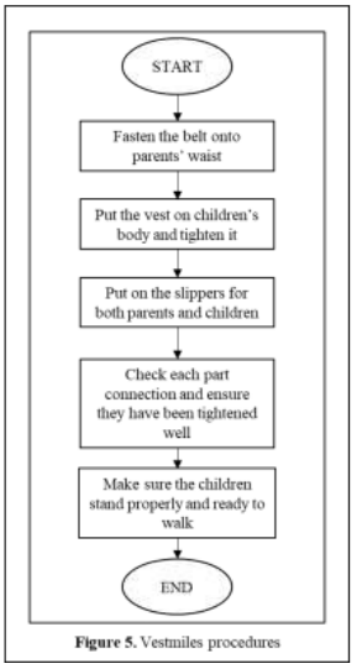

Figure 5. Vestmiles procedures

Technology has opened worlds for many disabled people, including peopel with cerebral palsy, through augmentation (for instance, wheelchairs driven by finger movements) and substitution (for instance, speed technology). Although mobility is the usual focus for parents of children with cerebral palsy in early childhood, language and communication are key in developing relationship and employment for adults with cerebral palsy [9]. Currently, robotic assists have been centered on and used in extending therapy for children. However, for technology to be effective and sustained over time, it should be user friendly, lightweight, adaptable, efficient and cost effective with evidence to support use.

The primary goal of physiotherapy intevention is to enhance a functional motor activity that is prioritized by the child and the family. The two main types of intevention that have been shown to be effective in individuals with cerebral palsy are task-specific skill training to improve motor coordination and performance, and physical training to address an underlying that may be limiting performance of the desired activity. Physiotherapy may cause pain such as assisted strecthing. It is the daily activity most frequently associated with pain despite the fact that in neurological condition, for example cerebral palsy, strecthing does not produce clinically important improvements in contractures of function [9].

To maximize motor learning, the patient must be actively engaged in the task both physically and mentally. Although, task specific should be able variable and incrementally challenging. Vestmiles tries to overcome such conditions in which a physiotherapy has to reduce the pain, yet it can reach the objective of the therapy itself. Relationship can be increase while children and parents are training and communicating. There is an emotional interction between them that the parents encourage their children during the therapy.

Conclusion

Cerebral palsy is the most common motor disability of childhood. One of the treatment is movement treatment by doing physiotherapy. Technology provides many devices for children CP such as robotic devices. Yet, it is not cost effective that may affect the sustainability of the device. Vestmiles can overcome these issues occured, particularly at the private school for children with disability and special needs. It is a user friendly, lightweight, adaptable, efficient and cost effective. Moreover, it will increase the motivation of children to join the training due to parents involvement. The developed relationship between children and parents can influence the success of the therapy.

Vestmiles walking device comprises 4 parts with the length and the height successively: a belt (47.3 cm; 23 cm), a vest (39.3 cm; 59 cm), and 2 pairs of slippers (26.9 cm; 9.9 cm for parents and 23.9 cm; 6 cm for children). It is able to support children weight up to 35 kg. The materials design are fabrics of MaxMara navy blue and woven micro polyester yellow. For further work, experimental tests is very important in order to collect evidence data to support use. Another materials can be considered which can be more reliable and long lasting. Gaining more respondent data can increase the accuracy of the design measurement. Providing various size such as extra small (XS), small (S), medium (M), and large (L) can be more adaptable.

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