Evaluation in design of walker trainer for spatial ataxic athetoid cerebral palsy children using kinect sensor as observation method for assessing body posture on walking

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Abstract. Balance is a general term that explains the dynamism of body posture to prevent someone from falling. During the child's growth sensory and motor disorders can be happen that reduce the ability to walk. Celebration Palsy (CP) is a type of disability that attacks child motor disorders. The main objective of this study is to evaluate the body balance of the CP child when using a walker trainer to assess body posture using the REBA method. The test running when the CP child is walking using a walker trainer, then a picture of the child's posture will be taken using the Kinect Sensor Microsoft XBOX One. Then do posture analysis using the REBA method and 3DSSPP software to find out the comparison results before and after using a walker trainer. The result from REBA score when using an old walker give a score of 9 with a level of risk in musculoskeletal risk, while REBA score when using a new walker give a score of 5. Low back compression result from 3DSSP software when using old walker is 807.7 lb and when using a new walker of 531.8 lb. this result can be accepted by respondents and within safe limits.

1. Introduction

Persons with disabilities are part of a society that has different abilities and difficulty to moving, so it is important to realize that persons with disabilities also have the same rights. Rehabilitation part of empowering for persons with disabilities. Rehabilitation has an objective to achieving mental, physical, psychological and social independence, also knowing the balance between what CP can do and what it cannot do. Children with disabilities have different characteristics than children in general, children with disabilities need special treatment caused by an abnormality. An activity improvement program needs to do so that persons with disabilities can develop their physical mobility abilities and doing daily activities without difficulty.

Mobilization is a basic human need that is needed by individuals to do daily activities such as joint movements, postures and gait for complete the activities and maintain their health [1]. The requirement of assistive devices for people with disabilities who experience limited physical mobility to support their daily activities, although it still requires a great deal of effort. The posture of the human body requires adjusting the position of the body to maintain the center of gravity during different activities [2]. Children with cerebral palsy (CP) have impaired ability to balance body posture [3, 4] People with CP have stiffness in some parts of their limbs, inability to direct body movements when walking.

Observations at Yayasan Penyandang Anak Cacat (YPAC), children with spatial type cerebral palsy sustain some stifness on their body. Observation at YPAC Surakarta for elementary school level (SD) it was noted that out of 24 students there were 15 students 62.5% who suffers physical limitations due to CP, which is 9 students suffers physical limitations due to illness and post-surgery or as much as 37.5% and 7 from 15 students classified into type II, III, and IV CP types. To supporting walking ability for children with CP in YPAC Surakarta Elementary School the childrens needed for a rehabilitation process to walk, generally using an assistive device such as a walker trainer. The design of the walker trainer uses the principle of child anthropometry CP, where the design is not only for stiff limbs but also for balancing the limbs. Observation method in children's CP complex in balancing the body when walking using Kinect Sensor Xbox One.

The observation method uses Kinect Sensor to assess the child's posture CP complex and REBA assessment to describe walking gait. The REBA method is used to determine the angles of the position of the body posture by taking pictures while walking. Then the score is compiled through the REBA method in the form of a work posture diagram or image and a REBA level scoring category. The evaluation of the results of the REBA score can determine the success rate of the rehabilitation process from the results of the walker trainer's design.

2. Research method

The subject of this research is spatial athetoid ataxic cerebral palsy children at YPAC Surakarta. The first step the pre-study includes field studies and literature studies. Identification of the problem of evaluating the way in which spatial children athetoid ataxic cerebral palsy (CP complex) is able to stand on the walker trainer design based on the observation method using kinect sensors to assess body posture with the REBA method. After problem formulation is obtained, then determine the purpose of the research to solve problems and can be implemented. After that identify the design requirement of walker trainer using a participatory.

2.1. Participatory

The participatory approach is used to bring an opportunity for stakeholders of CP children to be involved in decision making, and testing process to control the CP children while using the walker trainer [5]. There are four stakeholders involved in this study, parents, teachers, therapists, and doctors as entities that are very needed in facilitating and assisting CP children.

2.2. Identify design requirements

The next step is distributing questionnaires. The output obtained the most important needs for walker users. The results of the questionnaire will show up the requirements to design a walker trainer that's suitable for the needs of CP children and can resolve child's physical mobility disorder. The causes diagram as shown in Figure 1.

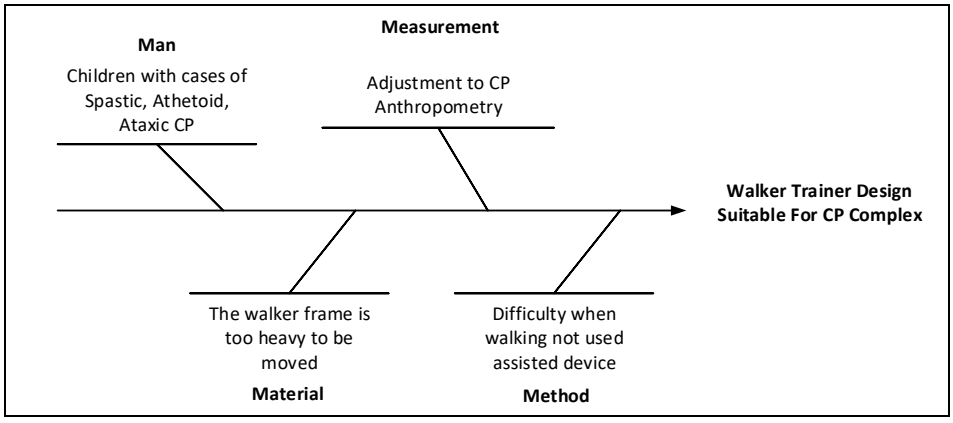

Figure 1. Cause effect diagram.

2.3. REBA
Analysis of user body measurements using the REBA (Rapid Entire Body Assessment) method. REBA is a posture assessment method to assess risk factors for overall body disorders [6]. For each task, assess the body posture factors with the assessment in each group consisting of 2 groups, i.e.: group A consists of upper and lower posture (trunk, neck, legs) and group B consists of right and left postures of (upper arm, lower Arm, and wrist).

2.4. Kinect sensor
Kinect is an input device for detecting motion produced by Microsoft for XBOX ONE Video Games and PCs with OS Windows. Kinect has features that can track the main human joint points called skeletal tracking. Skeletal tracking is not separated from the use of depth sensors [7]. Depth sensors see objects as a collection of small dots. The infrared projector constantly projects these points along the range area.

2.5. Software 3DSSPP
The 3D Static Strength Prediction Program (3DSSPP) is a program used to calculate the pressure that occurs in the lower spine. Besides that, it is also used to simulate a job and will provide estimates of data in work, workload, and anthropometry of male or female workers. Calculation of the pressure that occurs in the lower spine is in the 4th lumbar area and 5th lumbar area (L4 / L5), where's back injuries happens the most.[8]

3. Results and discussion

3.1. Design specification determination
Designing a prototype walker trainer by taking anthropometry data from respondents, the data taken is height, palm length, and elbow height of children CP Level III-IV as shown in the Table 1.

Table 1. Anthropometric data of respondents.

	Gender	Functional hand Reach	Elbow Height	Grip Diameter	Shoulder Breadth	*Hand Breadth*
Alneva	M	58.5	74	4	33.8	6.2
Azka	F	58	71.4	3	32	7

Table 1, it showed that there are differences size for every child, the walker trainer will be adjusted to the size of the respondent. Dimension calculations are needed to determine the size of the walker trainer's design. Dimensional calculations used, including:

3.1.1. Height walker trainer. Anthropometric data used in designing the height of the walker trainer from the surface of the floor is the height of the standing elbow. The 5th percentile is used so that it can accommodate children who have shorter standing elbows can use the walker trainer comfortably.

3.1.2. Wide walker trainer. Anthropometric data used to determine the width of the trolly handle is shoulder breadth (lb.) with the 95th percentile. The use of the 95th percentile is intended so that children with a greater shoulder width can hold the handle of the walker trainer freely and comfortably.

3.1.3. Length walker trainer. Anthropometric data used for the length of the walker trainer is functional hand reach with the 5th percentile. The use of the 5th percentile is intended so that children who have shorter hands can easily reach and operate a walker trainer and aim to provide more space for foot movements when operating a walker trainer.

3.1.4. Diameter walker trainer (frame). The anthropometric data used to determine the diameter of the walker trainer is grip diameter with the 50th percentile. The use of the 50th percentile is so that children who have a larger or smaller handheld diameter can hold the walker comfortably.

In addition to measuring anthropometric data in this study also used a questionnaire to determine the needs of children. The questionnaire to find out the criteria needed in designing a walker trainer. Criteria and Sub criteria shown in Table 2.

Table 2. Criteria and sub criteria.

Criteria	Sub Criteria
Accessibility	Accuracy of the function of using tool
Easy to Handle	Can be assembly disassembly
	Height of walker can be modified
Ergonomic	User Comfortable
	The load on the hand is not too heavy
	Maintain user balance
Tool Performance	Tool performance when supporting the user's body
	The size of the tool is according to user
Material accuracy	The material used is lightweight and solid
	Handgrip made in rubber
	Material durability (not easily fragile)

Based on the design references and weaknesses in the previous walker design, a walker design is made that is able to meet user requirements, one of the advantages of this walker design is that this walker can maintain the user's balance and prevent the user from falling. The concept design on the walker trainer is referred to as the application of assistive technology. The concept design that has been created, illustrated using Autodesk Inventor 2019, both in 2D and 3D images. The next stage is making a walker trainer. The product is the physical result of the walker trainer's design with all the components that have been conceptualized before.

Figure 2. Design and prototype walker trainer.

The design of the walker trainer for children with cerebral palsy has several parts that are the main focus, namely, the frame, the wheels and the material used .Frame is the most important part in all construction, this also makes the design of a construction frame must be made properly so that the frame function can be optimized in a construction, a sturdy frame because it has four legs so that the walker frame is balanced. There is a handgrip on the walker that makes the user more comfortable and safer when using a walker trainer. Wheels are one of the important factors in making walkers because the inappropriate wheel selection will affect the weight of the walker trainer. The bigger the wheel, the lighter the walker will run. The choice of the front wheel and rear wheel using brake because the front wheels function as steering, balancing, and the walker will be lighter when used to turn [8].Material selection must be accurate so that the function of walker trainer can be optimal. The material chosen for the manufacture of the prototype of the walker is stainless steel with a diameter of 16 mm. Stainless steel was chosen because of its light and solid so that when used walker is lighter and safer.

3.2 Analysis children's posture

Observation of CP children's posture is documenting using a camera and kinect sensor. Documentation did when the child goes straight ahead of the distance that has been determined. Furthermore, capturing movements are carried out to facilitate the assessment using REBA and 3DSSPP methods. Movement of the child when walking using a walker captured by the kinect sensor is shown in Figure 3. After the child's posture line is obtained, the next step is to make an angle at the trunk, neck, upper arm, lower arm, wrist. The angle of body posture shown in Figure 4.

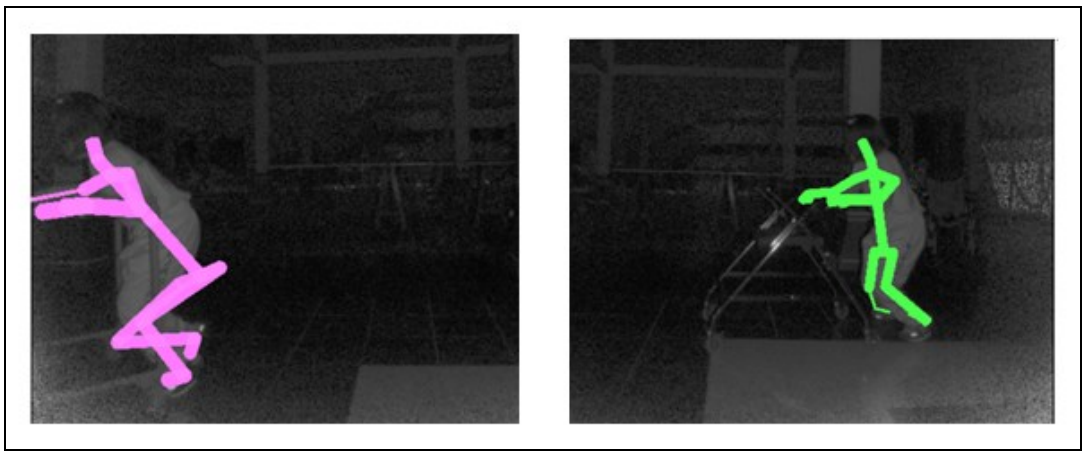

Figure 3. Skeleton tracking when using walker trainer.

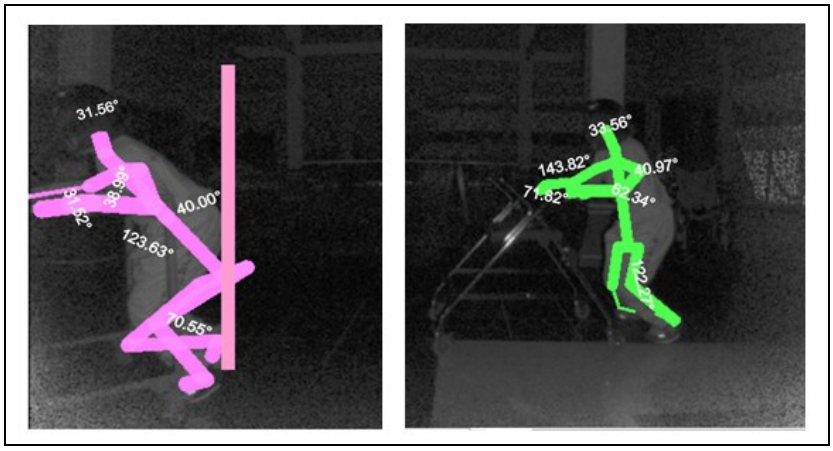

Figure 4. Drawing angle of body posture.

3.2.1. Body posture analysis using REBA Method (Rapid Entire Body Assessment). After knowing the posture and angle of each section, an operator work posture assessment will also be carried out on the activity under study, which aims to determine the possible level of risk due to the work posture carried out by the operator, assessment of the work posture using the REBA analysis method. The following picture is a summary of REBA scores when walking using a walker.

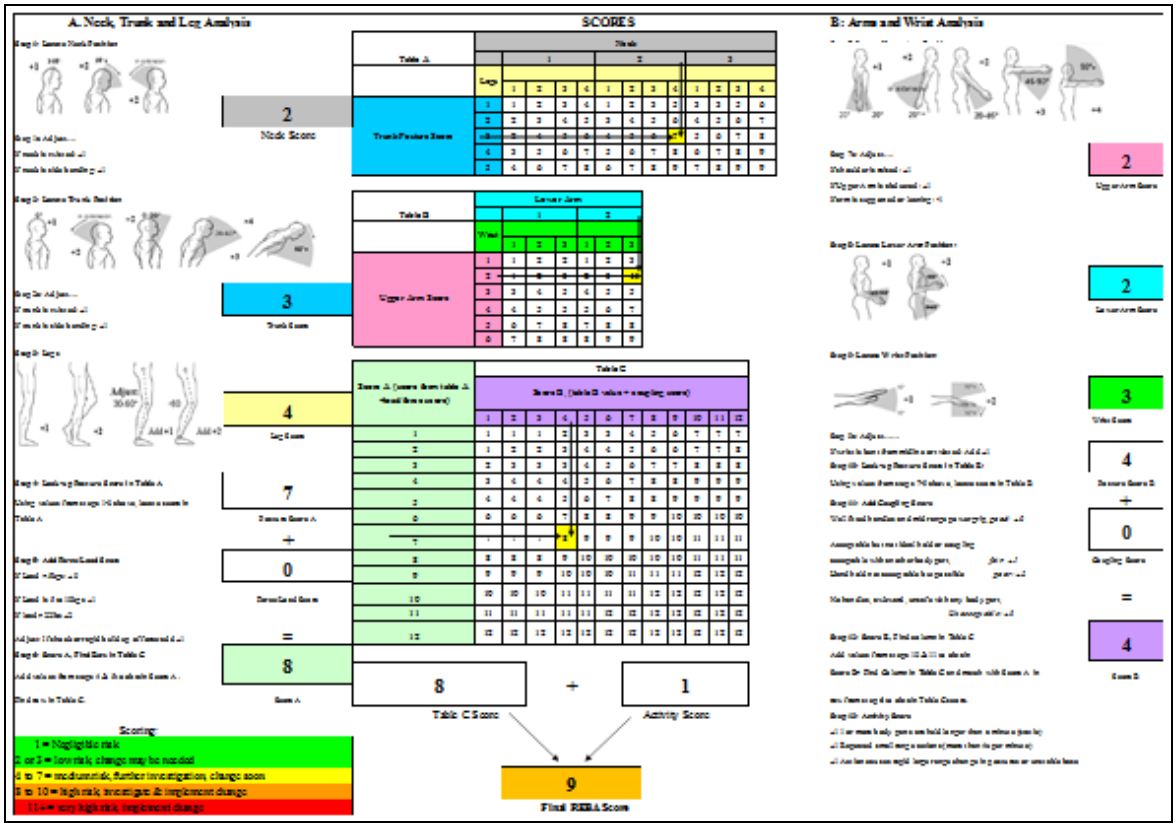

Figure 5. Scoring REBA when using walker trainer old version.

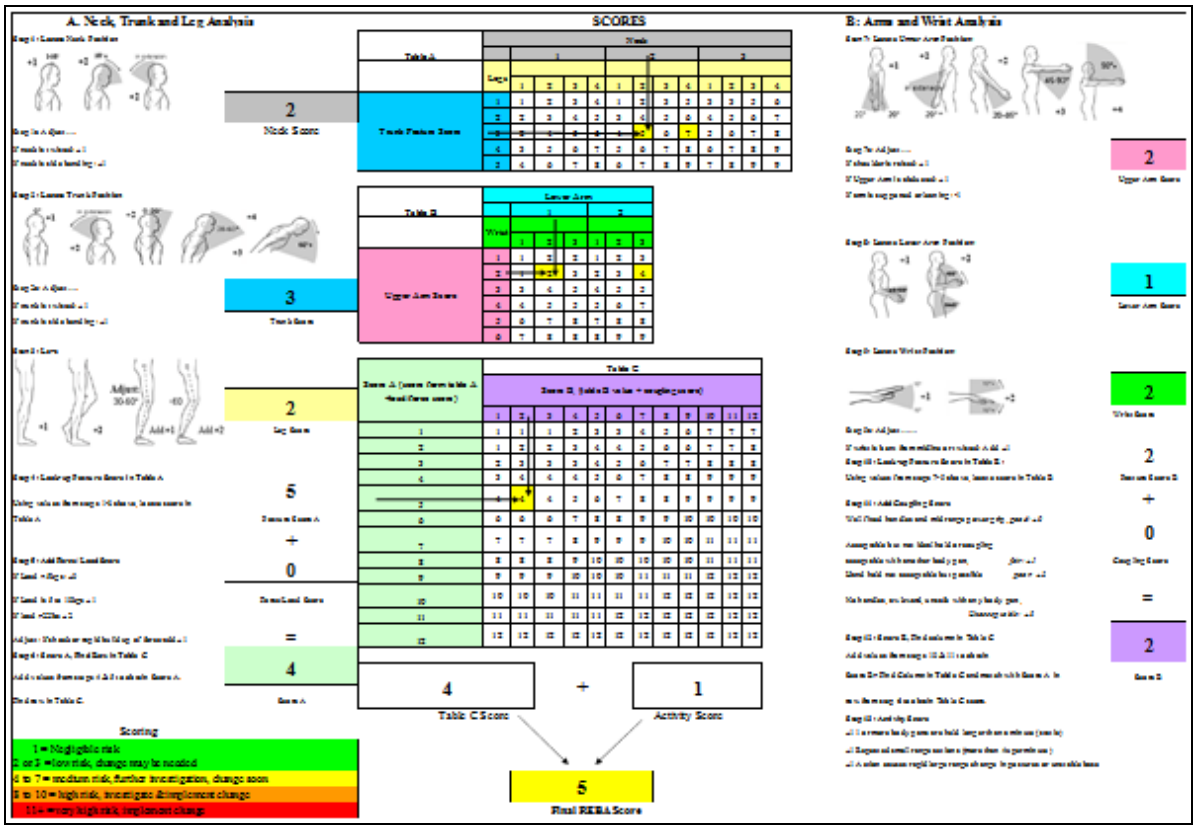

Figure 6. Scoring REBA when using walker trainer new version.

Based on the comparison of the 2 scores above it can be seen that the REBA score when using an old walker give a score of 9 with a level of risk in musculoskeletal risk high risk, it is necessary to investigate and take action to reduce work risk. While the REBA score when using a new walker give a score of 5 with a level of risk in musculoskeletal that is medium risk, further investigation and change soon.

3.2.2. Evaluation using 3DSSPP. The results of 3DSSPP processing can show how much force occurs in L5 / S1, if the value exceeds the maximum limit of the force borne by the operator then the posture is at risk because it can cause low back pain on the operator's body if left unchecked continuously, but cannot indicate the level of risk which occurs in a posture [9]. Body dimension data of each operator is used for the calculation of physical facilities analysis table which aims to find out whether the physical facilities on the vase production floor are in accordance with ergonomic values. Following are the results of a summary report analysis of the use of old and new walkers.

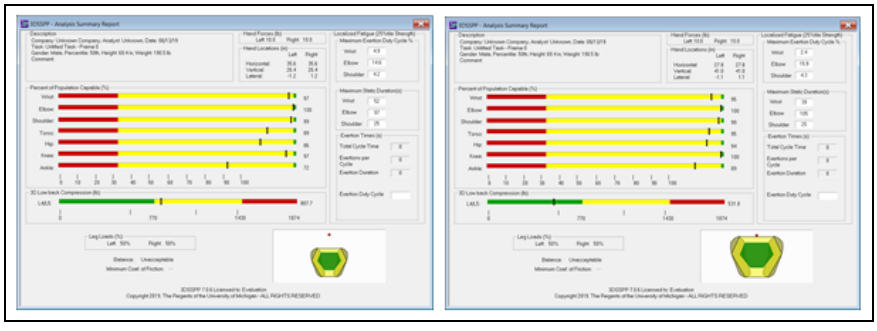

Figure 7. 3DSSPP report analysis.

From the results of the above output it can be seen that 3D low back compression when using an old walker of 807.7 lb. This states that the maximum force that occurs in L5 / S1 is still acceptable to the respondent but is in a middle risk position, because it is below the maximum force limit that can be borne the operator is 1874 lb. Whereas 3D low back compression when using a new walker of 531.8 lb, this states that the maximum force that occurs in L5 / S1 can be accepted by respondents and within safe limits.

4. Conclusions

This research succeeded in producing a prototype walker trainer through identification of user design requirements. It also can be concluded that the posture of using a new walker when walking shows a decrease in low back compression and risk level. Low back compression which was originally 807.7 lb to 531.8 lb. The risk level on the REBA score was originally 9 to 5. Both of these methods mean giving the same results, namely reducing the risk of musculoskeletal disorders and increasing the comfort and safety of CP children when walking using a walker.

5. References

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