Investigating the Psychosocial Impact of Upgraded Thai Folk-Designed Rehabilitative Devices on Children with Cerebral Palsy

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Abstract

Children with cerebral palsy can improve their physical development through physical therapy combined with rehabilitation equipment, which is a widely accepted method in the medical profession. However, accessing such equipment is becoming increasingly difficult due to the rising number of affected children, as well as the expenses and travel required for continuous therapy sessions. To address this issue, a device was developed based on traditional knowledge. However, its versatility was limited and did not fully meet the needs of its users. This study aimed to assess the psychosocial impacts of the device and evaluate user satisfaction through interviews with users and stakeholders. The initial assessment showed that the overall psychosocial impact was moderately positive, with adaptability inversely correlated with self-esteem. Furthermore, users were able to engage in more activities using the device, resulting in a positive self-esteem boost.

Keywords: Rehabilitative Devices, Cerebral Palsy, Physical Therapy, Psychosocial Impact Assessment, Adaptability, Self-esteem, Activities, Positive Self-esteem Boost.

1. Introduction

In order to improve the equipment and quality of life of children with disabilities before long-term use, an assessment was conducted to evaluate the impact of the device developed in this research on their daily living conditions. This assessment was conducted from the user's point of view, and the results were analyzed to understand the psychological and environmental outcomes of using the device (Arthanat, Wu, Buarer, Lenker, and Nochajski, 2009; Waraporn Panyawong, Benjaporn Saksiri and Pornpan Somboon, 2017).

This research has developed a measure of user perception that reflects how the device functions. The use of the Psychosocial Impact Assessment Scale (PIADS) has provided clear direction by quantifying the psychological and social feelings of users of the display

device. This tool is useful for multidisciplinary and design teams to better understand user sentiments and improve the device to fulfill the mental and social well-being of the user, as well as improve their quality of life and ability to live with society. By using the device, individuals with disabilities can develop a sense of self-worth, motivation to recover, and engage in various beneficial activities outlined in the program. As they progress, they can better absorb and understand their environment, and adapt to changing situations (Arthanat, Wu, Buarer, Lenker, and Nochajski, 2009; Caligari, Godi, Guglielmetti, Franchignoni, and Nardone, 2013).

Through observing the behavior of children who received rehabilitation assistance from folk wisdom devices, it was discovered that the children enjoyed the rehabilitation process facilitated by these devices. These devices were designed to be fun and enjoyable, and they stimulated the imagination while promoting the development of motor skills and balance. This made rehabilitation less boring and burdensome, and having such aids at home was found to be particularly helpful. The children were able to engage in various activities, including practicing sitting and standing balance, exercising muscle movement, and interacting with caregivers. The device development took into account the psychological concept of Maslow's hierarchy of needs theory (Avneet, 2013), which emphasized the importance of addressing not only rehabilitation but also the emotional needs of the users. By helping the children relax and calm down, they were more prepared to participate in their physical rehabilitation program.

To evaluate the psychosocial impact of device use, this study aimed to assess user perspectives (Jutai, Rigby, Ryan, and Stickel, 2000). The findings can be utilized to further develop assistive devices that are suitable and aligned with user needs. Utilizing the Psychosocial Impact of Assistive Devices Scale (PIADS) enables the emotional and social impacts of assistive device use to be deciphered, leading to improved quality of life for users. The collected data can be used to foster creativity and to interpret user experiences, ultimately providing insights for designers to develop more user-centric designs and activities (Day, Jutai, Woolrich, and Strong, 2001; Jutai, Woolrich, Campbell, Gryfe, and Day, 2000; Piyawat Triwitthaya, Jananya Panyamee Thippayom, Ninlapa Suangka and Pueanjai Rattakorn, 2016; Waraporn Panyawong, Benjaporn Saksiri and Pornpun Somboon, 2017). This process can result in a better understanding of user needs and can guide future design decisions.

2. Research Objective

The purpose of this study is to assess the impact of a newly developed device on children with cerebral palsy. The Psychosocial Impact of Assistive Devices Scale (PIADS)

and the Usability of Assistive Technology (USAT) assessment will be used to identify errors that will be corrected until passing the criteria. Once it passes these assessments, it can be used for real trials with individual users.

3. Methodology

This research employs an interpretive method that combines qualitative information from semi-structured interviews with findings from cognitive interviews for questionnaire testing. The study evaluates the psychosocial and emotional impact of using the device by using interviews and a psychosocial impact assessment form (PIADS). The focus is on the user's mental and social well-being and their ability to independently maintain good health and a high quality of life. The study also examines the behavioral expressions of device users, as reported by Jutai and Bortolussi (2003).

3.1 Participants

3.1.1 The study included a group of nine children with cerebral palsy who were receiving rehabilitation at the Special Education Center in Nakhon Si Thammarat Province. To be eligible for selection, the children had to meet certain inclusion criteria, such as being between the ages of 3-5 years and having all 32 organs, experiencing muscle spasms, and being able to sit or change from a lying position to a sitting position. Additionally, the children could not have received cognitive development stimulation before, had to have the same level of Motor Skill Standard System (GMFCS) (Level 4), and had to have a parent or caregiver present during treatment who had legal rights to participate in providing care.

There were also exclusion criteria, such as having complications with other systems diagnosed by a pediatrician at Maharaj Nakhon Si Thammarat Hospital, receiving physical therapy treatment or developmental promotion elsewhere, or experiencing illnesses from other conditions during the experiment.

3.1.2 Carers, physiotherapists, occupational therapists, and social science academics who had experience using the devices developed in this study with users and understood the different dimensions of psychological and social impact in various contexts were selected to test the confidence of the psychosocial impact assessment form. A total of 30 people participated in this test.

3.1.3 The rehabilitation equipment for children with cerebral palsy resulted from the integration of Thai folk wisdom elements into a single device, developed through a process of context analysis and user-centered design. The SAM and TRIZ methods were used to enhance design creativity, with SAM utilized to synthesize interrelationships between different sciences. The equipment comprises five main components: 1) arm muscle training set, 2) leg muscle training set, 3) sitting muscle training set, 4) standing muscle skills training

set, and 5) walking muscle skills training set. The selection of these components was based on an analysis of the rehabilitation approaches of users meeting inclusion and exclusion criteria, under the user context analysis approach of user-centered design (Hsiao and Chou, 2004; Ma, Wu, and Chen, 2006; Wu, Ma, and Chen, 2009; Manresa and Mas 2016) as following figure 1.

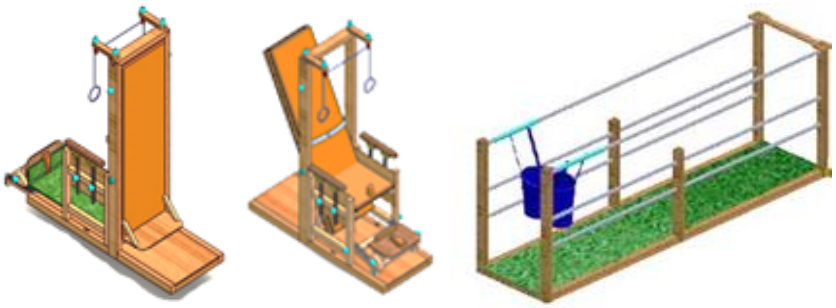

Figure 1 Rehabilitation equipment for children with cerebral palsy (Weerapong & Numnaphol (2018).

3.2 Research Instrument

3.2.1 Assessing the impact of rehabilitation devices on the psychosocial well-being of individuals

In this study, the psychosocial impact of a user-centered approach was evaluated using the Thai version of the Psychosocial Impact Assessment Scale (PIADS) developed by Piyawat Triwitthaya, Jananya Panyamee Thippayom, Ninlapa Suangka, and Pueanjai Rattakorn in 2016. The PIADS scale consisted of 3 main items and 26 sub-items, which were used to quantitatively measure the results and assist assessors and designers in accurately interpreting and understanding the outcomes. These results were used to improve equipment properties or develop new equipment to better meet the needs of users.

i) There are 12 sub-items in the list of emotions related to the capability to perform activities (competence).

ii) There are 6 sub-items in the list of emotions related to the ability to adapt to changing situations (adaptability).

iii) The list of emotions related to self-esteem (self-esteem) comprises 9 sub-items, each with a scoring system ranging from -3 to +3. The questionnaire uses a 7-level rating scale known as Likert's seven rating scale, where a score of +3 indicates a highly positive impact. The average score is compared to a specified score using the criteria established by Jutai and Day (2002).

An average score of -3 (or nearing -3) indicates an extremely negative impact, while an average score of -2 (or nearing -2) suggests a moderately negative impact. An average score of

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-1 (or nearing -1) implies a lesser negative impact, while an average score of 0 (or nearing 0) denotes no effect or change in feelings. An average score of +1 (or nearing +1) implies a small positive impact, while an average score of +2 (or nearing +2) suggests a moderately positive impact. Finally, an average score of +3 (or nearing +3) denotes an extremely positive impact.

4. Analysis of psychosocial impact and device usage ability in assistive technology.

Table 1 Cronbach's Alpha coefficient

Aspects of psychosocial effect	Alpha
Competence: The capacity to participate in tasks	0.712
Adaptability: Adjustment to varying circumstances	0.701
Self-esteem: Element of self-worth	0.784

Table 2 The proportion of impact ratings for each level (on the psychosocial dimension, gathered from 9 participants through an impact assessment form.

Item		Competence (Percentage)	Adaptability (Percentage)	Adaptability (Percentage)	Total
extremely positive	(+3)	6	15	42	21
moderate positive	(+2)	69	76	49	64
minimal positive	(+1)	25	9	7	14
no discernible	(0)	0	0	3	1
minimal negative	(-1)	0	0	0	0
moderate negative	(-2)	0	0	0	0
Extremely negative	(-3)	0	0	0	0

4.1 Reliability analysis. To ensure the reliability of the PIADS assessment form, a reliability analysis was conducted using the aforementioned rating scale.

The assessment device was developed for this study and the Cronbach's Alpha coefficient was determined to measure the reliability of each component of the assessment. A population of thirty individuals, who were unrelated to the sample, were included in the analysis to ensure confidence in the results. Table 1 revealed that all three components of the assessment had a Cronbach's alpha coefficient greater than 0.77 (Portney and Watkins, 2000), indicating that there is consistency among each sub-item within the same main item.

Table 3 The psychosocial impact assessment form includes data about the mean, standard deviation, and percentage scores for each of the three primary items

List	Competence	Adaptability	Self-esteem	Summary of all three items
Number of children	9	9	9	9
Number of items (N)	12	6	8	26
Mean (M)	1.83	2.05	2.29	2.02
Standard deviation	0.50	0.48	0.38	0.45
Percentage	61	69	75	68

Table 4 For 9 users, the psychosocial impact assessment form provides information on the mean score and standard deviation for each of the 26 sub-items.

List	Mean	standard deviation
1. Competence: The capacity to participate in tasks		
1. Performing necessary daily activities with ease	1.8	0.60
2. Achieving happiness and life satisfaction	1.6	0.73
3. Enjoying freedom in activities without assistance	1.7	0.50
4. Developing resilience to handle difficult situations	1.9	0.33
5. Avoiding confusion and indecision when faced with problems in daily activities	2.3	0.50
6. Efficiently managing various activities in daily life	1.6	0.73
7. Maintaining self-esteem and dignity	1.9	0.33
8. Engaging in a variety of activities each day.	1.9	0.33
9. Feeling secure in life	1.7	0.50
10. Overcoming frustration when desires are not met.	1.7	0.50
11. Believing that one is a valuable member of society.	1.9	0.33
12. Having confidence in managing daily tasks.	1.9	0.60
total 12 items	1.82	0.50
2. Adaptability: Adjustment to varying circumstances		
13. Acquiring knowledge in the process of daily activities	1.6	0.53
14. Possessing dexterity in performing daily activities	2.3	0.50
15 Maintaining positive thoughts about life and the future	2.1	0.33
16. Dealing effectively with problems during daily activities	2.2	0.44

List	Mean	standard deviation
17. Living a good quality life	2.0	0.50
18. Demonstrating skills in everyday activities	2.1	0.33
total 6 items	2.05	0.48
3. Self-esteem: Element of self-worth		
19. Feeling mentally strong	2.3	0.50
20. Following personal desires and goals	3.0	0.00
21. Avoiding feelings of embarrassment or shame	1.2	0.83
22. Being open to change and new challenges	2.7	0.50
23. Participating in activities with others	2.1	0.33
24. Having enthusiasm for new life experiences	1.8	0.44
25. Improving adaptability in daily routines	2.2	0.44
26. Responding confidently and quickly to opportunities to improve one's life	3.0	0.00
total 8 items	2.29	0.38

4.2 Examining the correlation between psychosocial impact and device usage ability.

To examine the correlation between the three primary components of psychosocial impact (PIADS) among device users and the four primary components of device usability by the Usability Scale for Assistive Technology (USAT). Assign each variable to its corresponding values.

PIADS includes three primary variables:
Pc represents activity performance ability
Pa represents adaptation to changing situations
Ps represents self-esteem

USAT includes four primary variables:
Ua represents activities and participation
Up represents device potential
Ue represents environmental factors
Uc represents user ability and skill

The table below illustrates the relationship between these variables.

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Table 5 The correlation coefficients between PIADS and UST, (N=9)

Items	Pc	Pa	Ps	Ua	Up	Ue	Uc
Pc	1						
Pa	.633	1					
Ps	.295	.737*	1				
Ua	.001	.416	.739*	1			
Up	.018	.005	.160	.161	1		
Ue	-.287	-.314	-.144	-.060	.564	1	
Uc	-.106	-.261	-.158	.061	-.747*	-.486	1

* The statistical significance level of their relationship was 0.05

4.3 Findings of the device use psychosocial impact assessment scale.

In Table 2, the results show that the medium positive impact level (+2) had the highest percentage at 64%, followed by the very positive impact level (+3) at 21%, and the low positive impact level (+1) at 14%. Only 1% of the respondents reported no psychosocial impact, and there were no negative impact levels found. This study emphasized the absence of any negative impact. Table 3 shows the mean scores of the three main items, which are the ability to perform daily activities, adaptability to changes, and self-esteem. The mean score for the ability to perform daily activities was at the medium positive impact level (M=1.83; S.D.=0.50). The mean score for adaptability to changes was also at the medium positive impact level (M=2.05; S.D.=0.48), while the mean score for self-esteem was at a moderate positive impact level (M=2.29; S.D.=0.38). The overall impact level was at a moderate positive impact level (M=2.02; S.D.=0.45). Despite the different mean scores among the three main items, all three items had a moderate positive impact level. The ability to perform daily activities had the lowest mean score, while the self-esteem aspect had the highest mean score.

4.4 Examining the average scores of individual sub-items in the psychosocial impact assessment form. In Table 4, it was observed that the impact levels for each sub-item were as follows:

i) For the 12 items under the ability to perform various activities, the average score indicated a moderate positive impact level for each item.

ii) For all 6 sub-items under adaptability, the average score indicated a medium positive impact level for each item.

iii) For all 8 sub-items under self-esteem, each sub-item had different impact levels. One item had a low positive impact level, four items had a medium positive impact level, and three items had a very positive impact level.

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4.5 Analyzing the Relationship between the Use of Assistive Devices and Psychosocial Effects.

The findings from examining the connection between psychosocial impact and device usage ability showed the following results: Based on Table 5, the impact level on adapting to changes (Pa) and self-esteem (Ps) were positively linked, with a correlation coefficient of 0.737 ($p<0.05$).

The device performance (Up) was negatively associated with user abilities and skills (Uc), as determined by a correlation coefficient of -0.747 ($p<0.05$) when analyzing the correlation coefficient between the four main items of the device-user competency assessment by USAT.

A positive correlation was observed between the result of the impact level on self-esteem (Ps) and the ability to apply to various activities (Ua), as shown by a correlation coefficient of 0.739 ($p<0.05$) when examining the correlation coefficient between variables from the three main items of PIADS and the variables from the four main items of USAT.

Regarding the relationship between psychosocial effects (PIADS) and ability in using equipment of USAT, the following findings were observed: When analyzing the correlation coefficients between the three main items of psychosocial impact in relation to rehabilitation equipment, it was found that the impact level on adaptation to changes (Pa) was positively correlated with the impact level on self-esteem (Ps). The correlation coefficient was 0.737 ($p<0.05$) as shown in Table 5. When analyzing the correlation coefficients between the four main items of the device-user competency assessment of USAT, it was found that the performance of the device (Up) was negatively correlated with the abilities and skills of users (Uc). The correlation coefficient was -0.747 ($p<0.05$). The correlation coefficient analysis between variables from the three main items of PIADS and variables from the four main items of USAT showed that the ability to apply to various activities (Ua) was positively correlated with the impact level on self-esteem (Ps). The correlation coefficient was 0.739 ($p<0.05$). The equipment is designed with a slope level adjustment feature that can only be operated by the user administrator for safety and appropriateness. Users are not authorized to adjust it on their own. To evaluate the psychological impact of the equipment on users, an error analysis is conducted, which analyzes the reasons behind the evaluation results of the 26 items that showed positive estimation errors.



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Figure 2 Training for the development of sitting posture skills.

Figure 3 Developing the skill to balance while seated and pulling the pulley can be accomplished through training.

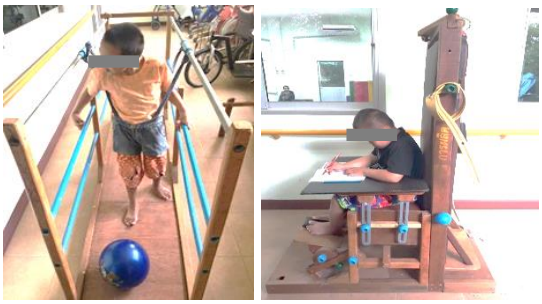
(a) (b) (c) (d)

Figure 4 Training in skills to enhance standing balance can be achieved through various techniques, such as: (a) maintain a 45-degree stance, (b) hold a 60-degree stance, (c) balance in a 90-degree stance, and (d) incorporate standing balance and pulley training.

Figure 5 Using a walking stick during practice can help improve one's walking abilities.

Figure 6 Extend your legs while in a seated position.

(a) (b) (c) (d)



(e) (f)

Figure 7 There are several ways to use equipment for various activities to enhance balance skills, such as: (a) Incorporating skill-building toys while seated (b) Practicing balance while seated and playing with toys (c) Playing with a ball to improve balance (d) Using toys to practice standing balance (e) Combining ball play with footwork to enhance balance skills (f) Practicing sitting balance while engaging in writing activities.

Figure 8 Try practicing your ball-touching skills while walking.

4.6 Analysis of Equipment Malfunction

4.6.1 The process of identifying the root causes of frustration and inability to achieve desired outcomes involved a team of professionals with different specialties. They observed and reflected on users who had limited physical abilities and relied heavily on their parents for daily activities. To improve their quality of life, recommendations were made for lifestyle changes and the use of rehabilitation equipment. However, using such equipment was a new and challenging experience for users that required patience and effort. Even though caregivers provided support and encouragement during training sessions, users' physical limitations led to frustration and a sense of unfulfillment. They expressed their emotions through shouting, body language, and refusal to participate in certain activities. During training sessions with pulley equipment designed to improve arm muscle strength and standing balance, users experienced trembling legs, pinched toes, and resistance to training.

4.6.2 Demonstrating Life Skills

At the beginning of the rehabilitation equipment training, users lacked confidence and were afraid to engage in activities using their devices. Many activities required the use of muscles in the arms, legs, and torso, resulting in tremors during training in sitting, walking, and standing balance, as well as while using the pulley arm.

5. Discussion

In this study, the psychosocial impact assessment of device users was conducted to evaluate the level of impact on various activities, adaptation to new situations, self-esteem, and overall well-being (Triwitthaya et al., 2016). The results indicate a moderately positive impact on all aspects, which is consistent with the impact levels observed in the use of assistive technologies for mobility aids. Specifically, previous studies have reported moderate positive impact levels (Burton, Nieuwenhuijsen, and Epstein, 2008; Arthanat, Wu, Buarer, Lenker, and Nochajski, 2009; Caligari, Godi, Guglielmetti, Franchignoni, and Nardone, 2013) in the psychological and social domains, which are reasonably consistent with its effectiveness

in concrete physical development that can meet the daily needs of the user (Scherer and Glueckauf, 2005; Triwitthaya et al., 2016; Panyawong et al., 2017). It is noteworthy that initial frustration may be experienced due to the device's novelty and unfamiliarity. Nevertheless, users eventually become relaxed and find joy in using the device for various activities. Moreover, users reported feeling more valuable to themselves and others and having a greater sense of independence. Ultimately, the device's positive impact on the psychosocial and physical well-being of users is a promising development in the field of assistive technologies. Based on the findings presented in Table 3, it was determined that the impact level of the device on the ability to engage in activities in daily life had a moderate positive effect with an average score of 61 percent (M=1.83; S.D.=0.5) (Triwitthaya et al., 2016). Users were able to perform a variety of activities independently, including sitting on their own and using their arms and hands to perform tasks such as throwing a ball into a basket or eating a snack. However, there were still some activities that required assistance from parents, such as brushing teeth or putting on clothes, where the user could maintain balance but needed help with the activity itself. In addition to these activities, users were also able to engage in standing activities with the device, such as holding a hoop to stretch both arms at the same time or lifting one leg to touch a ball (Triwitthaya et al., 2016). While these activities required some supervision from a caregiver, the equipment used in the training was stable and secure, capable of supporting the user's weight. As users continued to use the device, they showed increased commitment and cooperation, leading to improvements in their abilities to perform these activities. Furthermore, users were able to work on their lower body muscles by using the walker to touch a football with their feet while learning to walk (Triwitthaya et al., 2016). Although this activity required supervision, with practice, users were able to improve their skills and move more fluently. As a result of these improvements, users felt more confident in their ability to use their limbs and torso to engage in various activities.

These findings are consistent with previous research on the impact of assistive technologies on daily activities (Moons, Budts, & De Geest, 2006; Orellano & Jutai, 2013). Overall, the device was found to have a positive impact on users' abilities to engage in daily activities, although some activities still required assistance. Based on the results presented in Table 3, it can be observed that the impact of the device on adaptability was moderately positive, with a mean score representing the 69^{th} percentile (M=2.02; S.D.=0.45). The device facilitated the practice of sitting, balancing, and reclining, which helped users to improve their arm and leg movements, as evidenced by their ability to pick up and pull equipment better and to stretch and loosen their knee joints more effectively. The training stand of the device allowed users to adjust their torso resting angle to 90, 120, 150, and 180 degrees, thereby

enabling them to practice balancing on their feet. Moreover, the user's preference for practicing standing and walking on artificial grass with support sets for training to walk helped to increase their surface sense of touch and feel confident and prevent accidents during training. The impact of the device on users' self-esteem was also found to be moderately positive, with a mean score representing the 75th percentile (M=2.24; S.D.=0.38). Users reported feeling relaxed during skill training activities, which could be adjusted to their level of use for both sitting and standing positions. Users expressed delight in being able to practice and use the device themselves, which boosted their confidence and reduced feelings of frustration in other activities. The device's ability to provide enjoyable activities, such as using a soccer ball to practice leg movements and balance, or pulling the arm strength training pulley, motivated users to continue practicing and hope to help themselves without feeling embarrassed or frustrated. In conclusion, these findings demonstrate the positive impact of the device on users' adaptability and self-esteem (Kim et al., 2019 and Kim, K., Kim, K., & Kim, J. (2020)).

As per the correlation coefficient analysis, there exists a relationship between the PIADS and USAT, which can be explored by examining the correlation among the components of PIADS. The positive correlation between the level of psychosocial impact on adaptation to device use and the appreciative impact on oneself indicates that the device can contribute to positive emotions such as appreciation, happiness, self-confidence, and eagerness to perform tasks independently. Conversely, negative impact levels can lead to a negative impact on the user's self-esteem if the device fails to function as intended. Thus, the adaptation to device use and self-esteem are interrelated when considering the psychosocial effects of device users (Khezri et al, (2022)).

The relationship between PIADS and USAT is essential for users with mobility disabilities to adapt the device to their daily lives and use it for other activities to improve their quality of life, self-confidence, and happiness. Positive emotions can be a driving force for users to enhance their abilities and strength, as proven by several studies. Furthermore, the successful application of rehabilitation devices relies on matching the device's capabilities with the user's abilities and skills. Therefore, the development of a new device that combines various training features, such as sitting and balancing, arm and leg stretching, standing, and walking, is crucial to meet the user's context of use and ability.

Users can adjust the device's backrest and footrest to maintain an upright position and a comfortable posture without straining their body while practicing sitting and balancing. The device's slope and height can be adjusted to suit the user's sitting training needs. The correlation between the PIADS and USAT components suggests that the device's usability for daily life activities is positively correlated with the user's level of appreciative impact,

promoting a better sense of self-esteem. Interactive activities with others, such as games, talking, and socializing, can improve the user's emotional control, learning new skills, and living harmoniously with society. Therefore, designing devices that match the user's abilities and skills is critical in promoting successful rehabilitation outcomes (Jutai, Rigby, Ryan, & Stickel, 2000; Day, Jutai, & Campbell, 2002; Scherer, Sax, Vanbiervliet, Cushman, & Scherer, 2005; Demers, Monette, Descent, Jutai, & Wolfson, 2002; Lenker & Scherer, 2005; Hsieh & Lenker, 2006).

6. Conclusions

6.1 The findings of the study suggest that the overall psychosocial impact level of the device trial was moderately positive. The Device Users' Psychosocial Impact Assessment Scale (PIADS) showed positive impact on all three core items, indicating that users were able to perform activities with the device, adapt to changing situations, and experience increased self-esteem while using it. They also enjoyed using the device and did not feel constrained.

6.2 The relationship between PIADS and USAT can be summarized as follows: Firstly, there is a positive relationship between the impact level of adaptability and self-esteem in PIADS. Secondly, there is a negative correlation between the device's performance component and the user's ability and skill in USAT. Finally, there is a positive correlation between the stakeholder engagement activities component and the self-esteem impact level in USAT.

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