RESEARCH ARTICLE

Sensor Monitoring to Determine Daily Physical Functioning Among Post-Stroke Older People in a Home Setting: Pilot Study

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Abstract

Background: Almost half of the population of stroke patient were aged 65 and older. Elderly patients who had a stroke were at risk of loneliness and isolation due to their frailty, inactivity, and difficulty moving.

Objective: This study determined the daily physical functioning among post-stroke older people by sensor monitoring and matching data with the Functional Independence Measure (FIM).

Methods: Sixteen home-dwelling post-stroke older people participated in this descriptive cross-sectional study. Daily functioning was measured using Physical Activity Monitor AM300 sensor devices and FIM. In addition, data on stroke history, fall history activities, blood pressure measurements, walking speed, leg muscle strength, grip strength, balance, pain, fall risk, fear of falling, self-efficacy, and nutritional intake were collected as demographic characteristics of the participants.

Results: Most participants spent their time on at-home activities and very little time on sports activities. These findings were matched with FIM results where only one-fourth of participants had complete independence in locomotion walking, and no participants had complete independence in locomotion stairs.

Conclusions: Sensor monitoring and FIM could be combined to determine daily functioning and the type of rehabilitation needed by post-stroke patients.

Keywords: *Sensor monitoring, functional status, post-stroke, older people/adults, daily functioning*

Introduction

Stroke is the number one cause of death worldwide (Feigin et al., 2015) and third in disability (Johnson et al., 2016). Despite the reduction of mortality in developed countries, stroke is sharply increasing. Approximately three-quarters of strokes occur among individuals aged ⩾ 65 worldwide (Benjamin et al., 2018). This trend is experienced in Indonesia where almost half of the stroke patients were 65 and older (Indonesian Basic Health Research, 2018). Older people with stroke were at risk for loneliness and isolation due to their frailty, inactivity, and difficulty moving after stroke (Pedersen et al., 2020). In addition, the combination of aging and stroke incidence is a significant cause of independence loss and disuse syndrome due to paralysis, that consequently affects daily functioning among older people and alters their ability for self-care (Saleh et al., 2021; Sosiawati et al., 2021).

Self-care is an essential aspect to maintain independence among older people and this includes Activities of Daily

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Living (ADL) such as mobility, moving in bed, sitting and transferring, eating, dressing, bathing, performing personal hygiene, and toileting (Aslani et al., 2016). Half of the post-stroke patients discharged from a hospital experience severe ADL impairment and less self-care (Schnitzler et al., 2014). Moreover, 75% of post-stroke patients had a higher risk of falls due to low balance ability and muscle weakness (Hirase et al., 2015). Hence, continuous improvement of ADL abilities and prevention of physical functioning deterioration by disuse are crucially pressing issues among such patients in the community.

The Functional Independence Measure (FIM) is one of the most used tests to determine functional and self-care status (Chumney et al., 2010). This said test measures ADL abilities in post-stroke patients. However, when patients are aware that they are being measured, they often show their best performance. Thus, true performance of daily functioning among post-stroke older people at-home is rarely measured. It is essential, therefore, to acquire an accurate description and more precise information of how post-stroke older people perform their daily functioning in a home setting.

One of the objective tools used to monitor daily functioning at-home is sensor application. Sensor monitoring in the living environment can provide early detection of disability because sensing visualizes minimal changes that post-stroke patients and their family members cannot identify (Pol et al., 2016). Previous studies have monitored the ability of older people to do ADL using sensing models installed in their home environment (Murakami et al., 2017; Shogenji et al., 2016). Unfortunately, most studies have primarily focused on the technical issue of the sensor model rather than its daily application and clinical practice (Pol et al., 2013). A foremost consideration in this study is that sensors have not been applied to post-stroke patients; therefore, monitoring is urgent for this illness with deteriorating conditions.

In Indonesia, when post-stroke patients return to their homes, no specific community-health program is available to help them gain maximum independence to perform ADL. Hence, more effort is needed to reduce stroke burden and complications. Data derived from this study can be used as baseline information for health professionals to design appropriate self-care programs for post-stroke patients. Furthermore, it is expected that such undertaking can prompt urgency to set up community-based rehabilitation services for post-stroke patients and older people whose aging process worsens stroke consequences. This study, furthermore, aims to determine daily physical functioning among post-stroke older people in the community using sensor monitoring and matching data with FIM. Moreover besides identifying technical problems using wearable sensor devices, this study also wants to describe the characteristics of home-dwelling post-stroke older people since their condition affects functioning abilities such as walking speed, grip and leg muscle strength, balance, self-efficacy, fear of falling, nutritional status.

Methods

This was a descriptive cross-sectional study of 16 home-dwelling post-stroke older people. The participants were recruited from four public health center working areas in Makassar using purposive sampling. The sample size of 16 was determined based on recommendations for pilot studies, which suggest that the number of participants should be more than 12 in order to test the feasibility of an intervention with continuous measurement (Kunselman, 2024). Makassar is a metropolitan city in the Eastern part of Indonesia. The inclusion criteria were post-stroke individuals aged 55 and over with hemiplegia, walking either with or without a walking aid, and living with family members. The exclusion criteria were acute diseases or unstable chronic diseases. If the participants stopped wearing the sensor devices before one week, they were considered dropouts.

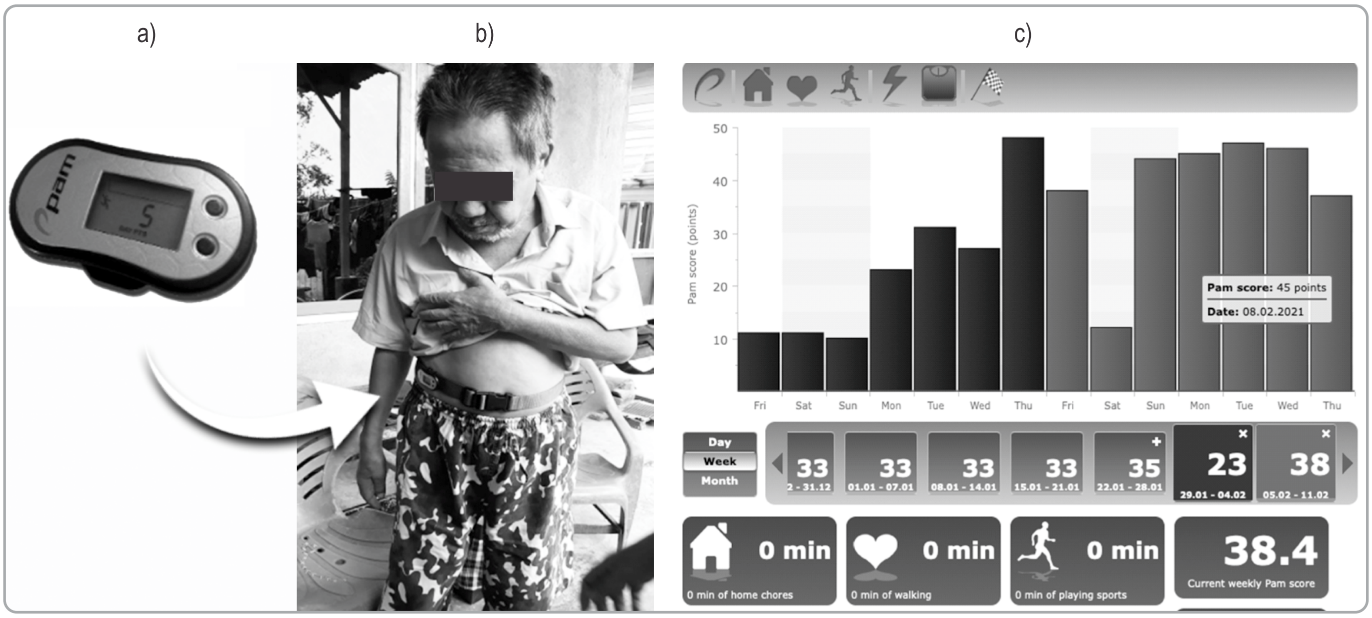
Measures

The following measurements were taken: demographic data, fall, stroke and rehabilitation history, stroke self-efficacy, nutritional status, hand grip, leg strength and reach test. These measurements were taken once, as they are not expected to change in a short time. In addition to the one-time measurements, dynamic and continuous data including daily physical functioning measured by the sensor devices, blood pressure, and walking speed were collected daily for seven consecutive days. It was necessary to record a minimum of seven days of sensor data to accurately estimate index activity levels (Pamcoach, 2011)

Daily Physical Functioning

Physical Activity Monitor (PAM) AM300 wearable sensor device (http://www.pamcoach.com) was utilized to measure patients' activity levels, the kinds of activities performed, and calories spent on a weekly and daily basis. The PAM AM300, a 3-dimensional accelerometer 68 x 33 x 10 mm was used on the participant's right hip with an attached belt (Figure 1). The accelerometer was used continuously for 7 days, except during sleep and when taking a shower. This device has been used in several studies and tested for reliability and validity. The test–retest reliability of the PAM AM300 was ICC 5 0.80 with a 95% confidence interval (CI) of 0.28 and 0.92 and intra-

Figure1. *PAM AM300 sensor monitoring system. a) PAM AM300 sensor b) PAM AM300 sensor in position on the right hip of the participant c) sensor results in display website. Figures a and c were retrieved from www.pamcoach.com with permission.*



CV 5 of 1.5%. The PAM AM300 is a valid tool to objectively measure and monitor daily physical activity (Slootmaker et al., 2005, 2009). PAM produced data from zone mode (minutes spent in performing activities) and activity index (points made due to moving in minutes and calories burned). Zone mode is divided into Living Zone (fidgeting, doing chores around the house and moving slower than 4 km/h); Health Zone (walking or similar activities and moving between 4 and 7 km/h); and Sports Zone (running or similar activities and moving faster than 7 km/h). The PAM AM300 activity index score was based on a 24-hour activity period and eight times more sensitive to enable higher PAM scores. In addition to the PAM, the FIM was also used to predict daily functioning and self-care. The FIM has 18 items divided into two subscales - motor and cognitive functions, where 13 items assess motor functions and 5 items assess cognitive functions. Each item is scored on a 7-point scale, ranging from 1 = total assist (<25% independence) up to 7 = complete independence (100% independence). The higher the score, the greater the patient´s functional abilities.

Other Variables

Demographic data (sex, age, living arrangement, and educational level), stroke history, fall history, and rehabilitation adherence were measured by a questionnaire. Blood pressure was measured with the Omron HEM-6323T automatic blood pressure monitor (Omron Corporation; Kyoto, Japan). A numerical rating scale measured pain with a response: 0 no pain, 2 hurts a little bit, 4 hurts a little more, 6 hurts even more, 8 hurts a lot, and 10 worse pain (Thong et al., 2018). Walking speed was measured by the 4-Meter Walk Test. The 4-Meter Walk test has shown excellent test-retest reliability for older adults (Peters et al., 2013). Grip strength was measured with a J-Tech Commander Grip Track (Zevex Company, Tokyo, Japan). Leg muscle strength was measured by μtas MT-1 (Anima Inc., Tokyo, Japan). Balance was measured by the forward reach test, the right reach test, and the left reach test. This measurement has a high test-retest reliability (ICC = 0.90 – 0.95) in stroke patients (Katz-Leurer et al., 2009). The Timed Up and Go Test was used to measure fall risk (Hiengkaew et al., 2012). The Visual Analog Scale for Fear of Falling (VAS-FOF) measured fear of falling with scores ranging from 1, no fear to 10, very afraid. Self-efficacy was measured by the Stroke Self-Efficacy (SSE) questionnaire, which consists of 13 statements with a 0 to10 response range with 0 not confident and 10 very confident. The minimum score is 0 and the maximum 130. The higher the score, the higher the self-efficacy. The SSE questionnaire has high internal consistency with a Cronbach´s alpha of 0.90 (Jones et al., 2008). Nutritional intake and status were measured by the Mini Nutritional Assessment (MNA). The MNA consists of 18 items with a total score ranging from 0 to 30. MNA. The MNA has satisfactory test-retest reliability and is helpful for repeatedly assessing the nutritional status of post-stroke patients (Guigoz et al., Lin et al., 2019).

Data Collection Procedures

The list of potential participants' names, address and contact numbers were collected from the nurses at the Public Health Centre after informing them of this study's inclusion and exclusion criteria. Before visiting the potential participants' homes, the researchers called to ask for permission to visit them in person in order to confirm their present condition. Once the potential participants agreed to meet, home visits were conducted. Upon having confirmed the participants' conditions, their informed consent to participate in the study was requested.

To conduct measurements, the assignment of different responsibilities based on our expertise was carried out. Nurses collected demographic data, information on fall, stroke and rehabilitation history, and stroke self-efficacy. Physiotherapists recorded hand grip, leg strength and reach test results, while a nutritionist assessed the participants' nutritional status. To ensure proper use of PAM AM300 device, two research assistants with nursing qualifications visited participants' home every morning for 7 days. These research assistants who had received 3 hours of training regarding the study were responsible for measuring the participants' blood pressure and walking speed during their daily visits to the participants' homes. Data collection was conducted after the participants had their breakfast and had a shower.

To ensure that the sensor device continuously collects data, the PAM USB receiver was connected to a personal computer on the third day of the participant visit session. After logging in to the PAM Online Coach website, the daily activity level data was immediately uploaded, displayed, and stored on Pam Web Page.

Ethical Considerations

Ethical approval was first obtained from the Ethical Committee of Hasanuddin University. Due to the morning home visits required that may inconvenience both the participants and their respective families, detailed explanation of data collection procedures was provided prior to the receipt of their written informed consent. Throughout the study, participants were assured of their privacy, confidentiality, voluntary participation, and anonymity, all in accordance with the standards of the Declaration of Helsinki.

Statistical Analysis

Data were analyzed by IBM SPSS Statistics for Windows version 22.0 (IBM Corp., Armonk, NY, USA). Functional status of participants were described as minimum-maximum and mean ± standard deviation. As for the performance of daily activities using the FIM score and demographic characteristics that were based on activity index, frequencies (counts and percentages) and mean ± standard deviation were used to summarize data of categorical and continuous variables, respectively.

Results

Participants' functional status based on index activity measurements and the FIM are shown in Table 1. Based on sensor monitoring, most of the participants' time were spent on at-home activities (inside houses) and very little time on sports activities. In addition, most participants performed eating, grooming, and recall memory with complete independence (Table 2). Half could transfer to and from the bed to chair independently. However, only one-fourth could perform locomotion in walking with complete independence while none had complete independence for locomotion on stairs.

Table 1. *Participants Functional Status (n−16)*

Functional Status	Min-max	Mean ± SD
Index Activity*	3-35	18.28±10
Living Zone (mins)	14-24	103.56±58.6
Health Zone (mins)	4-67	27.81 ±19.6
Sports Zone (mins)	0-3	0.69±0.9
FIM Total	28-125	106±27.5
FIM Motor	23-90	75.19±20.7
FIM Cognitive	5-35	30.81±8.4

Note: *The activity index : inactive, <20; active,
FIM: Functional Independence Measure. Total scores, ranging from 18–126, were used to determine the patient's degree of assistance to accomplish basic routine daily tasks (Linacre et al., 1994).

Demographic characteristics based on the two group's participants' index activity are displayed in Table 3. The number of men (56.3%) and women (43.8%) was equal. More than half were still living with their spouses and children (68.8%). All participants (100%) with an active activity index could walk independently, whereas only 37.5% of nonactive participants could walk independently. More than three-fourths (75%) had the last stroke onset more than a year before. Nearly all participants (93.8%) did not attend a rehabilitation program. The number of participants who never fell in the active group was the same as that in the nonactive

Table 2. *Performance of daily activity based on FIM (n = 16).*

Items	Total assistance	Maximal assistance	Moderate assistance	Minimal assistance	Supervision/ set up	Modified independence	Complete independence
	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)
Eating	2 (12.5)	0 (0)	0 (0)	0 (0)	0 (0)	1 (6.3)	13 (81.3)
Grooming	0 (0)	1 (6.3)	0 (0)	0 (0)	0 (0)	2 (12.5)	13 (81.3)
Bathing	2 (12.5)	1 (6.3)	0 (0)	2 (12.5)	0 (0)	2 (12.5)	9 (56.3)
Dressing upper	2 (12.5)	0 (0)	0 (0)	0 (0)	0 (0)	3 (18.8)	11 (68.8)
Dressing lower	2 (12.5)	0 (0)	1 (6.3)	0 (0)	0 (0)	4 (25)	9 (56.3)
Toileting	1 (6.3)	0 (0)	0 (0)	2 (12.5)	0 (0)	2 (12.5)	11 (68.8)
Bladder	1 (6.3)	0 (0)	1 (6.3)	1 (6.3)	1 (6.3)	1 (6.3)	11 (68.8)
Bowel	1 (6.3)	0 (0)	0 (0)	1 (6.3)	2 (12.5)	0 (0)	12 (75)
Transfer bed-chair	3 (18.8)	0 (0)	0 (0)	1 (6.3)	1 (6.3)	3 (18.8)	8 (50)
Transfer toilet	0 (0)	2 (12.5)	0 (0)	1 (6.3)	2 (12.5)	3 (18.8)	8 (50)
Transfer shower	0 (0)	2 (12.5)	0 (0)	1 (6.3)	2 (12.5)	4 (25)	7 (43.8)
Locomotion on walking	0 (0)	2 (12.5)	0 (0)	2 (12.5)	1 (6.3)	6 (37.5)	5 (31.3)
Locomotion stairs	4 (25)	0 (0)	0 (0)	1 (6.3)	2 (12.5)	9 (56.3)	0 (0)
Comprehension	1 (6.3)	0 (0)	0 (0)		1 (6.3)	2 (12.5)	12 (75)
Expression	1 (6.3)	0 (0)	0 (0)	1 (6.3)	0 (0)	4 (25)	10 (62.5)
Social interaction	1 (6.3)	0 (0)	1 (6.3)	0 (0)	0 (0)	3 (18.8)	11 (68.8)
Problem-solving	1 (6.3)	1 (6.3)	0 (0)	1 (6.3)	1 (6.3)	2 (12.5)	10 (62.5)
Memory	1 (6.3)	0 (0)	1 (6.3)	1 (6.3)	0 (0)	0 (0)	13 (81.3)

Note: FIM: Functional Independence Measure.

group who had a fall history (62.5%). Fall risk scores were much larger among nonactive participants than active participants (78.14 78.9 VS. 19.36 5.9). In addition, active participants showed higher SSE scores than nonactive participants (112.88 15.4 VS. 74.13 35.6). Related to the FIM score, the total FIM motor score, which involves capabilities to perform movements of daily activity, was greater among active participants than nonactive participants (88.37 1.8 VS. 62 22.8). In addition, total scores were greater among active participants compared to nonactive participants (122.12 3.72 VS. 89.87 31.9)

Based on observation, most participants used their sensor devices daily. However, there were some technical problems using sensors in an at-home setting. First, some participants complained of feeling itchy around the belt area during humid and high temperatures. In addition, the placement of the sensor device also needs to be observed daily because it should be correctly located at the right hip for the correct reading of daily activity. Some participants sometimes forgot to attach their belt with the sensor device immediately after waking up to record their whole day's activity.

Discussion

This study aimed to determine daily physical functioning among post-stroke older people in the community by using sensor monitoring and matching it with FIM. FIM findings showed that participants could perform basic daily activities independently. Only one-fourth were able to perform independently, primarily related to walking and movement. This result shows daily physical functioning ability or what participants can do. Some of the most common impairments after stroke were physical activity restriction, difficulty gripping or holding items such as a stair rail and incomplete use of limbs (Australian Institute of Health and Welfare, 2011).

Sensor monitoring findings also showed that participants' time is mainly spent inside their houses and not moving much. Post-stroke patients experience a physical decline that leads to sedentary lifestyles (Outermans et al., 2016). They spent nearly 11 hours daily sitting (English et al., 2016). Previous studies have also found that outdoor activities might be challenging for post-stroke patients due to physical

Table 3. *Demographic Characteristics based on two groups of participants index activity (n = 16)*

Variables	All Subjects (n=16)	Non active (n-8)	Active (8)
Sex			
Male	9 (56.3)	4 (50)	5 (62.5)
Female	7 (43.8)	4 (50)	3 (37.5)
Age (years)			
Mean (SD)	65.38±7.2	67.63±8.7	63.13±4.7
Living arrangement			
Children	5 (31.3)	3 (37.5)	2 (25)
Spouse + children	11 (68.8)	5 (62.5)	6 (75)
Education Level			
Low	8 (50)	4 (50)	4 (50)
High	8 (50)	4 (50)	4 (50)
Systolic BP (mmHg)			
Mean (SD)	151.9±19	147.17±23.6	156.63±12.9
Diastolic BP (mmHg)			
Mean (SD)	86.6±10.6	84.44±12.7	88.74±8.4
Walking ability			
Independent	11 (68.8)	3 (37.5)	8 (100)
With walking aid	2 (12.5)	2 (25)	0 (0)
Family assistance	3 (18.8)	3 (37.5)	0 (0)
Pain during walking			
Yes	4 (25)	3 (37.5)	1 (12.5)
No	12 (75)	5 (62.5)	7 (87.5)
If yes, Pain level			
Mean (SD)	0.88±2.1	1.50±2.8	0.25±0.7
Last onset			
<1 year	4 (25)	1 (12.5)	3 (37.5)
≥ 1 year	12 (75)	7 (87.5)	5 (62.5)
Attack frequency			
First time	15 (93.8)	7 (87.5)	8 (100)
>1 time	1 (6.3)	1 (12.5)	0 (0)
Hemiplegia			
Right	8 (50)	4 (50)	4 (50)
Left	8 (50)	4 (50)	4 (50)
Rehabilitation attendance			
Yes	1 (6.3)	0 (0)	1 (12.5)
No	15 (93.8)	8 (100)	7 (87.5)
Fall history			
Yes	8 (50)	5 (62.5)	3 (37.5)
No	8 (50)	3 (37.5)	5 (62.5)
Last time Fall			
Never	8 (50)	3 (37.5)	5 (62.5)
< 1 year	2 (12.5)	2 (25)	0 (0)
≥ 1 year	6 (37.5)	3 (37.5)	3 (37.5)
VAS Fear of Falling			
Mean (SD)	3.19±3.5	5.25±4.1	1.13±0.3
Walking speed (secs)			
Mean (SD)	22.36±27.3	36.05±34.1	8.67±2.2
Fall risk (secs)			
Mean (SD)	48.75±62	78.14±78.9	19.36±5.9
SSE total			
Mean (SD)	93.50±33.2	74.13±35.6	112.88±15.4
MNA total score			
Mean (SD)			

	12.06±2.1	11.88±2.4	12.25±1.9
Index activity Mean (SD)	18.28±10	10.15±4.1	26.40±6.9
Living zone (mins) Mean (SD)	103.56±58.6	65.25±32.15	141.87±54.4
Health zone (mins) Mean (SD)	27.81 ±19.6	13.38±5.1	42.25±17.8
Sports zone (mins) Mean (SD)	0.69±0.9	0.25±0.5	1.12±1.1
Right-hand grip (N) Mean (SD)	107.05±90.7	70.25±64.2	143.85±102.1
Left-hand grip (N) Mean (SD)	94.42±56.1	84.52±45.7	104.32±66.6
Right quadriceps strength (Kg) Mean (SD)	9.83±4.4	8.05±5.4	11.62±2.2
Left quadriceps strength (Kg) Mean (SD)	9.43±3.9	7.75±4.2	11.11±2.8
Forward reach test (Cm) Mean (SD)	29.61±13.4	22.9±14.5	36.31±8.3
Right reach test (Cm) Mean (SD)	15.5±7.1	12.11±8.2	18.91±3.7
Left reach test (Cm) Mean (SD)	14.4±8.0	10.96±9.1	17.92±5.2
Total FIM motor Mean (SD)	75.19±20.7	62±22.8	88.37±1.8
Total FIM cognitive Mean (SD)	30.81±8.4	27.88±11	33.75±3.1
Total FIM Mean (SD)	106±27.5	89.87±31.9	122.12±3.72

Note: SD: Standard Deviation; BP: Blood Pressure; SSE: Stroke Self-efficacy; MNA: Mini Nutritional Assessment. A cut-off of 24 points is classified as an indication of being well-nourished, 17–23.5 points indicate a risk of malnutrition, and <17 points indicate the person is malnourished. FIM: Functional Independence Measure.

barriers that do not appear inside a controlled environment at-home (Törnbom et al., 2018). Those sedentary lifestyles would worsen immobility due to skeletal muscle loss, muscle structure change, and bone mass loss (Borschmann et al., 2012). Therefore, stimulating them to be gradually more active should be a target.

Sensor monitoring findings confirmed the FIM result because they showed and represented the participants' actual performance. FIM shows the ability of participants to perform daily physical activities, while the sensor shows how often participants perform daily physical activities. Information from FIM and sensor monitoring can be essential for health professionals because more knowledge about the individual performance after a stroke can guide them in designing suitable and efficient interventions (Törnbom et al., 2018). Sensor monitoring could also assist in coaching more effectively without increasing time spent (M. C. Pol et al., 2017).

The total self-efficacy score was also greater in the active participants' group. Participants with lower self-efficacy scores had a lower activity index. Inactive people are often unaware of how passive they are (Slootmaker et al., 2005). Future research integrating sensor monitoring as feedback combined with rehabilitation programs could stimulate self-efficacy, which is individual belief to perform certain task in achieving goals (Harsul et al., 2020), in order to increase participants´ daily physical functioning. Utilizing patients' progress in previous intervention studies has successfully increased and maintained self-efficacy among older people with chronic disease (Irwan et al., 2016).

Another aim of this study was to identify any technical problems using wearable sensor devices for home-dwelling post-stroke older people. Most participants adhered to using their sensors based on daily observation. In developing countries like Indonesia where older people live with extended families under one roof, wearable devices are ideal. This wearable sensor enables us to monitor the daily physical functioning of older people among other family members living in the same place. However, due to the itchiness around the hips of some participants when they used a belt as a sensor attached tool, some decided to attach it to their trousers. Another consideration was that daily visits are still needed to ensure they attach their sensor correctly and remind them to wear their sensor device. Future research will be conducted applying ointment to relieve itchiness and using phone calls or text messages for caregivers to remind daily usage of sensors. In addition, developing a sensor device that is easier to use by placing it on the wrist has also been considered.

The urgent need to set up rehabilitation to restore post-stroke people's daily physical functioning ability in Indonesia was also learned. Many post-stroke Indonesians live in the community without rehabilitation (Sosiawati et al., 2021). When asked why they did not attend rehabilitation, distance, and cost in terms of transportation, and the rehabilitation fee were the main reasons. In developed countries, after stroke, multidisciplinary teams provide rehabilitation services in wards with physicians, physiotherapists, speech therapists, occupational therapists, and psychologists to fulfill the needs of patients based on impairment (Vluggen et al., 2012). In Indonesia, when the critical stroke period has passed, patients must return home. Though given the option to have rehabilitation after returning home, only limited hospitals and clinics in Indonesia provide rehabilitation services supported by the Indonesian public health insurance. In addition, there is no follow-up program from the hospital or closest public health center after stroke. Therefore, daily physical functioning after rehabilitation will depend mainly on patients and their families. These conditions are similarly found in several developing countries. The community-based rehabilitation program is critically required to move rehabilitation services closer to the community to prevent permanent disability among post-stroke patients who have a decrease in quality of life and are a burden for home caregivers. (Fu et al., 2020). Moreover, as an essential element of the recovery of post-stroke patients, a family member or caregiver could be more accessible to attend rehabilitation sessions with patients (Fu et al., 2020; van der Laag et al., 2021).

Continuous and standardized monitoring of physical functioning could provide a solid solution as it improves the visibility of physical activity. It can also be used to assess and improve individual activity levels. However, it is important to note that simply providing health workers with a device to measure and to visualize patient movement behaviour does not guarantee its adoption in primary health care settings (Valkenet et al., 2023). Implementing PAM in clinical settings requires careful attention. A previous systematic review recommended that physical activity interventions using accelerometers/sensor monitoring were most successful when they integrated multiple behavior change techniques (de Leeuwerk et al., 2022). Therefore, another study on how to integrate PAM to healthcare institution needs to be conducted. In addition, it is essential to have an easy-to-use, user-friendly, and inexpensive monitoring tool that can validly measure physical activity and be used for an extended period of time due to its battery durability. This PAM AM300 allows for measurement data to be used by another person after the initial participant's measurement period has ended (Pamcoach, 2011). The individual measurement data is safely stored ont the website. However, this poses a challenge since such device is not available in Indonesia and other developing countries. Considering the production of similar tools in Indonesia and other developing countries is important to ensure accessibility.

Limitations

There are several limitations of this pilot study. First, the different ways in which the PAM AM300 was attached (belt or trousers) may have affected the accuracy of the data. Second, the small number of participants may have influenced the results. Third, differing times of stroke onset among post-stroke patients could also impact the findings. Additionally, the one-week measurement period for determining current daily physical functioning may have been too short. Furthermore, assessment of comorbidities among participants affecting their level of physical activity was not carried out. Lastly, participants' history of exercise prior to their stroke which may have impacted their level of activity was not also examined. The past history of inactivity among individuals might also explain why they do not engage in physical activity after experiencing a stroke.

Conclusions

Based on sensor monitoring, most of the participants´ time was spent on at-home activities (inside houses) and very little time on sports activities. These findings were matched by FIM results that capture daily physical functioning ability. Only one-fourth of participants had complete independence in locomotion walking, while none had complete independence in locomotion stairs. These two functions are needed for independence in daily functioning. It is highly suggested that sensor monitoring and the FIM could be used together to determine daily physical functioning ability in order to arrive at an accurate description of daily activities that will be a topmost consideration for the type of rehabilitation needed by community post-stroke patients.

Recommendations

Future research with a larger homogenous sample size, assessment of comorbidities, and a prolonged period of sensor use are needed to follow daily activity over time and determine any decrease in activity. Equally recommended is the involvement of family members to ensure the proper usage of PAM AM300.

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