Journal of Palestine Ahliya University for research and studies
مجلـة جامعة فلسطين الأهلية للبحوث والدراسات
ISSN: 2959-4839
Vol. 01 Issue 02 (2022)

The Effectiveness of Using AFO with Stroke in Developing Functional Performance

Azzam Alarab[1]*, Rana Alhaj[1], Mohammad Hammad[1]
[1] Faculty Allied Medical Health Sciences, Palestine Ahliya University (Palestine)
* azzam@paluniv.edu.ps

Received:17/08/2022 Accepted:23/09/2022 Published:01/12/2022

Abstract:

The study goal is to find out the impact of using AFO on balance, gait, and daily life activity of chronic stroke patients. Single case experimental design study. The case study focuses on patients who have a chronic CVA, one patient will undergo the AFO, then be assessed by measurement and tests regarding balance by the Berg Balance Scale, gait by Wisconsin Gait Scale and ADL by Barthel Index for two weeks before dressing AFO and after dressing it. The findings show that there is a clear significance in scores which resulted for the patient pre and post using AFO, the balance score for the patient before using AFO was 26/56 but after it shows a better result it was 40/56 ,and the ADL score for the patient before wearing AFO was 40/100 , after using AFO it becomes 75/100, also the gait improve clearly in stance phase and swings as measurement shows, therefore it was concluded that the AFO is very good for stroke patients to improve their balance , gait, and ADLs. The study concluded that the use of orthotics has a good effect on balance, gait, and ADLs. This single-case experimental design study explores the impact of ankle-foot orthosis (AFO) on balance, gait, and activities of daily living (ADLs) in chronic stroke patients. Findings indicate significant improvements in balance, gait, and ADL scores after two weeks of AFO use. The study underscores the effectiveness of AFO in enhancing functional outcomes and highlights its value in stroke rehabilitation.

Keywords: *Ankle Foot Orthosis; Balance; Gait; Activity of Daily Living; Stroke.*

Journal of Palestine Ahliya University for research and studies
مجلـة جامعة فلسطين الأهلية للبحوث والدراسات
ISSN: 2959-4839
Vol. 01 Issue 02 (2022)

فعالية استخدام AFO مع السكتة الدماغية في تطوير الأداء الوظيفي

عزام العرب[1]*، رنا الحاج[1]، محمد حماد[1]
[1] كلية العلوم الطبية المساندة، جامعة فلسطين الأهلية (فلسطين)
azzam@paluniv.edu.ps *

تاريخ الاستلام:2022/08/17 تاريخ القبول:2022/09/23 تاريخ النشر:2022/12/1

ملخص:

هدفت الدراسة إلى معرفة تأثير استخدام AFO على التوازن، والمشي، ونشاط الحياة اليومي لمرضى السكتة الدماغية المزمنة، واتبعت الدراسة منهج التصميم التجريبي لحالة واحدة. تركز دراسة الحالة على المرضى الذين يعانون من مرض الشريان التاجي المزمن، حيث سيخضع مريض واحد لعملية AFO، ثم يتم تقييمه عن طريق القياس والاختبارات المتعلقة بالتوازن بواسطة مقياس بيرج للتوازن، والمشي بواسطة مقياس ويسكونسن للمشي، وADL بواسطة مؤشر بارثيل لمدة أسبوعين قبل تلبيس AFO، وبعد تلبيسه، وأظهرت النتائج أن هناك أهمية واضحة في الدرجات التي نتجت للمريض قبل وبعد استخدام AFO، وكانت درجة التوازن للمريض قبل استخدام AFO 26/56؛ ولكن بعد أن أظهرت نتيجة أفضل كانت 56/40، وكانت درجة ADL للمريض قبل ارتداء AFO 40/100، وبعد استخدام AFO تصبح 100/75، كما تحسن المشي بشكل واضح في مرحلة الوقوف والتأرجح كما يظهر القياس، لذلك تم استنتاج أن AFO جيد جدًا للسكتة الدماغية المرضى لتحسين توازنهم، مشيتهم، وADLs. وخلصت الدراسة إلى أن استخدام الأجهزة التقويمية له تأثير جيد على التوازن، والمشي، وADLs. تستكشف هذه الدراسة بتصميمها التجريبي للحالة الواحدة تأثير جهاز التثبيت الكاحلي–القدمي (AFO) على التوازن والمشي والأنشطة اليومية للمرضى الذين يعانون من السكتة الدماغية المزمنة. تشير النتائج إلى تحسن ملحوظ في درجات التوازن والمشية والأنشطة اليومية بعد استخدام AFO لمدة أسبوعين. تسلط الدراسة الضوء على فعالية AFO في تعزيز النتائج الوظيفية وتسليط الضوء على قيمته في عمليات إعادة تأهيل المرضى المصابين بالسكتة الدماغية.

الكلمات المفتاحية: *تقويم الكاحل والقدم؛ التوازن؛ المشية؛ نشاط الحياة اليومية؛ السكتة الدماغية.*

1. Introduction

Stroke causes substantial levels of functional disability in the chronic stage and is the second most common cause of death worldwide (Feigin et al., 2022). Hemiplegia is the most frequent symptom following a stroke, which causes numerous alterations in motor function (Kuriakose & Xiao, 2020).

In different nations, the crude annual incidence of stroke ranges from 41/100,000 to 297/100,000. The overall incidence of stroke is still on the decline in high-income nations while rising in low- and middle-income nations. Between 10% to 40% of cases ended fatally after 28–30 days. In countries with low and intermediate incomes, the death rate is rising. The nations with the greatest case-fatality rates have not changed. In low- and middle-income nations, where less aggressive therapies are used, stroke incidence and case fatality rates are greater than in high-income nations. In order to lower the prevalence of stroke in low- and middle-income countries, population-based measures are required (Ding et al., 2022).

Many investigations have shown that muscle tone and strength change after a stroke depending on where and how much brain tissue is damaged (Chu et al., 2022). In addition to these changes, these people may also have impairments in their coordination, visual, vestibular, and sensory systems (Ishiwatari et al., 2022).

Hemiplegic patients who undergo stroke-related changes in gait performance exhibit noticeable speed reductions, postural asymmetry, and abnormalities in balance and postural control (De Paula et al., 2019). Affected people must significantly adapt to their situation due to the various capacities and adaptations brought on by a stroke (Visvanathan et al., 2019; Deyhoul et al., 2020).

A person's ability to function after a stroke is negatively impacted by gait issues because they change how other people view their functionality and capacity for social interaction. These might also incite prejudice against this population's perceptions of a person's standard of living (Khatkova et al., 2019). Reduced mobility and functionality were found to have a detrimental effect on quality of life in a study of stroke survivors, and those who had poorer gait quality and speed scored lower on the scale (Ramos-Lima et al., 2018).

Ankle-foot orthoses (AFO), an external device worn on a lower limb, are one form of assistive device that physical therapy utilizes to improve a stroke patient's gait. It stabilizes the joints and provides a better gait. Depending on the need or the progression of the situation, it may be prescribed throughout any phase of rehabilitation (Totah et al., 2019).

Maintaining balance is a challenging process in which postural adjustments are achieved in response to both voluntary activity and outside disturbances (Luger et al., 2019). In order to map sensation to action and ensure the anticipatory and adaptive features of postural control, postural control depends on the integration of data from many sensory systems, including the vestibular, proprioceptive, and visual systems (Sinno et al., 2021; Aflalo et al., 2022).

A quantitative post-urography system is a device that monitors minor changes in subjects' ability to maintain balance as well as changes in the postural control system. An evaluation method similar to a test tube is a balancing master system. It determines the relative importance of a variety of sensory inputs required for balance, including as vision, vestibular feeling, and proprioception (Zamysłowska-Szmytke et al., 2022). This study sought to determine the impact of foot and ankle orthoses on daily activity, gait, and balance in chronic stroke patients.

2. Methods and Materials

Experimental design research with one case. This investigation was carried out on a 55-year-old male patient at the Palestine Ahliya University's physiotherapy department. Chronic stroke was the official diagnosis. Hemiplegia has affected him for the past seven months.

The following criteria were required for inclusion: (1) age between 40 and 75 years; (2) participant gender; (3) stable condition; and (4) history of chronic stroke. Otherwise, the exclusion criteria are: (1) acute stroke; (2) age of less than 40; and (3) age of more than 75.

The case's intervention involved wearing an AFO for two weeks. Patient is evaluated before and after wearing an AFO for two weeks using the Wisconsin Gait Scale (WGS), It is a measure for evaluating quality of walking in persons after a stroke (Smith & Patritti, 2022), and the Berg balance scale, the most often used clinical scale, was utilized to evaluate balance skills. It was developed by Katherine Berg and is frequently used to assess a person's dynamic and static balance abilities, particularly in neurological conditions. It is broken down into three categories: sit balance, permanent balance, and dynamic balance. It consists of 14 activities divided into the following categories: sitting balance (1), standing balance (9), dynamic balance (4), and has a special score (0-4): 4 normal, 0 needs assistance (dependent), the highest possible score is 56 (Meseguer-Henarejos et al., 2019).

The Barthel Index (BI) was created to evaluate the level of disability in individuals with disorders affecting the neuromuscular and musculoskeletal systems. The Royal College of Physicians has advised against using it frequently while assessing older patients (22, 23, 24). There are ten entries in all, each describing a different activity. Each item scores are combined to provide a final score that ranges from 0 (completely reliant) to 100. (totally independent). A lower score on the BI denotes a greater reliance on ADL. Here is an interpretation of the scores: 80–100 are "independent," 60–79 require little assistance with ADL, 40–59 are "somewhat dependent," 20–39 are "extremely dependent," and 20 are fully dependent (Yi et al., 2020).

3. Results

This study included a single case of stroke for a 55-year-old patient. He was diagnosed with a chronic stroke. He has been suffering from hemiplegia for 7 months. There were distinct differences in the AFO dressing of balance outcomes. Differences in favor of the subsequent group 2 weeks after AFO dressing; moderately assisted walking with an average of 40, and pre-group squats before wearing the AFO; Moderate assisted walking an average of 26. This means wearing an AFO for a stroke patient assist to improve balance. Table 1. These results are illustrated.

Table 1. Berg balance scale results pre- and post- dressing AFO.

Number	Before AFO dressing	After two weeks from AFO dressing
1	2	4
2	2	3
3	1	4
4	1	2
5	2	4
6	2	4
7	2	4
8	2	2
9	2	2
10	4	2
11	1	1
12	2	2
13	2	3
14	1	3

Total score	**26/56**	**40/56**

As shown in the table below, the results indicated clear differences in activities daily living for stroke case. Differences in favor of the post-dressing group after 2 weeks of AFO dressing averaged 75, the reversals of the pre-group before AFO dressing averaged 40. It was concluded that the AFO dressing helped to improve ADL. Table 2. These results are illustrated.

Table 2. Barthel index results pre- and post- dressing AFO.

Activities of daily living	Before AFO dressing	After two weeks from AFO dressing
Feeding	10	10
Grooming	5	5
Bathing	5	5
Bowels	0	0
Dressing	5	5
Bladder	5	10
Toilet Use	0	5
Transfer (Bed to Chair And Back)	5	15
Stairs	0	5
Mobility (On Level Surfaces)	5	15
Total score	**40/100**	**75/100**

The results in the table below indicated that there were clear differences in the stance phase affected by the leg. The differences are in favor of the subsequent group after two weeks of AFO dressing with an average of 9, reversals for the previous group before AFO dressing with an average of 16. The results revealed that the AFO dressings help improve walking, especially in the case of the leg affected by standing in case of stroke. Table 3. These results are illustrated.

Table 3. Wisconsin gait scale results pre- and post- dressing AFO.

Stance phase affected leg

Stages	Before AFO dressing	After two weeks from AFO dressing
use of hand held gait aid	5	3
stance time on impaired side	3	2
step length of unaffected side	3	1
weight shift to the affected side, with or without a gait aid	3	2
stance width	2	1
Total score	**16/17**	**9/17**

As shown from the table below, the results indicated distinct differences in the affected toe. The differences in favor of the post group after 2 weeks of AFO dressing with an average of 2, the reversals of the previous group before the AFO dressing with an average of 4. It is concluded that the AFO dressing helps to improve walking especially in the affected toe of the leg for stroke condition. Table 4. These results are illustrated.

Table 4. Wisconsin gait scale results pre- and post- dressing AFO.

Toe Off Affected Leg

Stages	Before AFO dressing	After two weeks from AFO dressing
Guardedness	2	1
hip extension of affected side	2	1
Total score	**4/6**	**2/6**

The results showed clear differences in swing phase of affected leg. The differences are in favor of the post-dressing group two weeks after AFO dressing with an average of 10, reversals for the previous group before AFO dressing with an average of 16. AFO elicits adjunctive dressing to improve walking especially in the swinging phase of the affected leg for the stroke case. Table 5. These results are illustrated.

Table 5. Swing phase affected leg pre and post dressing AFO.

Stages	Before AFO dressing	After two weeks from AFO dressing
external rotation during initial swing	3	2
Circumduction at mid swing	2	1
hip hiking at mid swing	2	1
knee flexion from toe off to mid swing	3	2
toe clearance	3	2
pelvic rotation at terminal swing	3	2
Total score	**16/18**	**10/18**

As shown from the table below, results indicated distinct differences in the affected heel strike. Differences in favor of the post-dressing group after 2 weeks of AFO dressing with an average of 2, reversals of the previous group before AFO dressing with a mean of 3. Table 6. These results are illustrated.

Table 6. Heel strike affected leg pre and post dressing AFO.

Initial foot contact	Before AFO dressing	After two weeks from AFO dressing
Score	**3**	**2**

4. Discussion

The goal of this study is to know the effectiveness of AFO on gait, balance, and activity of daily living for stroke patients.

The current study findings showed that there was an improvement in the patient's gait stages after wearing AFO after 2 weeks from a disturbance in gait, there also was a clear difference in balance pre and post wearing AFO the patient stability and balance improved, also there was a positive effect and very clear difference in patients ADL.

Kesikburun et al. (2017) reported the impact of ankle-foot on functional ambulation and strengthening for gait parameters with stroke patients, as the scores for cadence, walking speed and ankle flexion on heel strike and the period from maximum knee flexion until the tibia is perpendicular

to the ground were increased during ambulating with AFO compared to ambulating with bare feet ($p < 0.05$). There was a significant reduction in stride time and a significant increase in stride length and contralateral foot contact with the AFO on the affected side ($p< 0.05$). Individual support time decreased significantly with AFO on the unaffected side ($P < 0.05$). The functional ambulation category score improved significantly with AFO ($p < 0.05$). In this study, there was a positive effect of using AFO on gait parameters.

The role of an ankle-foot orthosis on walking in stroke patients was mentioned by Choo and Chang (2021). The results showed that in stroke patients, the AFO was helpful for enhancing gait speed, cadence, step length, and stride length. Using AFO can also help patients with 18 strokes who have issues with ankle dorsiflexion weakness or hyper-plantar flexion because the sagittal plane angle of the ankle, knee, and hip is improved. When administering AFO to stroke patients in clinical practice, this meta-fundamental analysis's results can be utilized as a guide (Kesikburun et al. 2017). This study demonstrated a considerable improvement in walking (gait).

The impact of a rigid ankle-foot orthosis on postural control and functional mobility in chronic ambulatory stroke patients was documented by Akulwar and his friends. They discovered that usage of inflexible AFO had a noticeable negative impact on functional mobility and static and dynamic postural control in chronic ambulatory stroke patients (Choo & Chang 2021). Our research emphasized how crucial it is to utilize AFOs to improve gait.

The immediate effects of wire-based AFO on rest balance in stroke patients with foot drop, a crossover study was demonstrated by Lee and colleagues. The results showed that the use of AOW resulted in immediate effects on static balance in patients with stroke compared to those with bare feet. The use of UD-Flex AFO showed no immediate effects on static balance compared to the bare foot condition (Akulwar & Bane, 2020). The current study results found a good value of using AFO on balance.

The impact of daily usage of bilateral ankle-foot orthoses manufactured to order on balance, falling fear, and physical activity in the elderly was demonstrated by Wang and friends. According to the findings, AFO walking shoes combined with bilateral walking shoes that are specially made are more effective at improving balance than walking shoes alone, significantly reducing fear of falling, and showing a non-significant but significant increase in physical activity when compared to baseline. Moreover, the results suggest that older persons who had poor balance at baseline and had a higher daily adherence to AFO use would benefit more from the AFO intervention (Lee et al., 2020). In our research, we discovered that an AFO could reduce falls by enhancing balance.

AFO's effects on balance and walking after stroke have been demonstrated by Tyson and Kent (2013). AFO use can result in an immediate improvement in walking (speed and step/stride length), functional ambulation categories, and some elements of balance (weight distribution in standing). The Timed Up & Go test and Timed Stair Climb tests for mobility and balance were unaffected by the AFO (postural sway). The findings suggest using an AFO to enhance walking and some aspects of balance, although further research into the long-term effects of AFO use is needed (Wang et al., 2019). Our research shown that utilizing an AFO to improve mobility by addressing balance issues had a significant impact.

The strength point is there is no study focused on the effect of dressing AFO on ADL with a stroke patient, also there are no studies specialized in chronic stroke in terms of balance and gait accurately. While Vulnerabilities are that the experiment was applied to one person only, and the experiment was done in a short time.

5. Conclusion

The current study shows that there is a clear and positive effect of using ankle and foot orthotics in improving the quality of walking, balance and daily life activity.

References

Aflalo, J., Quijoux, F., Truong, C., Bertin-Hugault, F., & Ricard, D. (2022). Impact of Sensory Afferences in Postural Control Quantified by Force Platform: A Protocol for Systematic Review. Journal of personalized medicine, 12(8), 1319. https://doi.org/10.3390/jpm12081319

Akulwar, I. S., & Bane, A. V. (2020). Effect of Rigid Ankle Foot Orthosis on Postural Control and Functional mobility in Chronic Ambulatory Stroke Patients. J Neurol Neurosci, 11(4), 328. DOI: 10.36648/2171-6625.11.4.328

Choo, Y. J., & Chang, M. C. (2021). Effectiveness of an ankle-foot orthosis on walking in patients with stroke: a systematic review and meta-analysis. Scientific reports, 11(1), 15879. https://doi.org/10.1038/s41598-021-95449-x

Chu, C. L., Lee, T. H., Chen, Y. P., Ro, L. S., Hsu, J. L., Chu, Y. C., Chen, C. K., & Pei, Y. C. (2022). Recovery of walking ability in stroke patients through postacute care rehabilitation. Biomedical journal, S2319-4170(22)00104-4. Advance online publication. https://doi.org/10.1016/j.bj.2022.07.004

De Paula, G. V., da Silva, T. R., de Souza, J. T., Luvizutto, G. J., Bazan, S. G. Z., Modolo, G. P., Winckler, F. C., de Oliveira Antunes, L. C., Martin, L. C., da Costa, R. D. M., & Bazan, R. (2019). Effect of ankle-foot orthosis on functional mobility and dynamic balance of patients after stroke: Study protocol for a randomized controlled clinical trial. Medicine, 98(39), e17317. https://doi.org/10.1097/MD.0000000000017317

Deyhoul, N., Vasli, P., Rohani, C., Shakeri, N., & Hosseini, M. (2020). The effect of family-centered empowerment program on the family caregiver burden and the activities of daily living of Iranian patients with stroke: a randomized controlled trial study. Aging clinical and experimental research, 32(7), 1343–1352. https://doi.org/10.1007/s40520-019-01321-4

Ding, C., Wu, Y., Chen, X., Chen, Y., Wu, Z., Lin, Z., Kang, D., Fang, W., & Chen, F. (2022). Global, regional, and national burden and attributable risk factors of neurological disorders: The Global Burden of Disease study 1990-2019. Frontiers in public health, 10, 952161. https://doi.org/10.3389/fpubh.2022.952161

Feigin, V. L., Brainin, M., Norrving, B., Martins, S., Sacco, R. L., Hacke, W., Fisher, M., Pandian, J., & Lindsay, P. (2022). World Stroke Organization (WSO): Global Stroke Fact Sheet 2022. International journal of stroke : official journal of the International Stroke Society, 17(1), 18–29. https://doi.org/10.1177/17474930211065917

Ishiwatari, M., Tani, M., Isayama, R., Honaga, K., Hayakawa, M., Takakura, T., Tanuma, A., Kurosu, A., Hatori, K., Wada, F., & Fujiwara, T. (2022). Prediction of gait independence using the Trunk Impairment Scale in patients with acute stroke. Therapeutic advances in neurological disorders, 15, 17562864221140180. https://doi.org/10.1177/17562864221140180

Kesikburun, S., Yavuz, F., Güzelküçük, Ü., Yaşar, E., & Balaban, B. (2017). Effect of ankle foot orthosis on gait parameters and functional ambulation in patients with stroke. Turkish journal of physical medicine and rehabilitation, 63(2), 143–148. https://doi.org/10.5606/tftrd.2017.129

Khatkova, S. E., Kostenko, E. V., Akulov, M. A., Diagileva, V. P., Nikolaev, E. A., & Orlova, A. S. (2019). Sovremennye aspekty patofiziologii narusheniĭ khod'by u patsientov posle insul'ta i osobennosti ikh reabilitatsii [Modern aspects of the pathophysiology of walking disorders and

their rehabilitation in post-stroke patients]. Zhurnal nevrologii i psikhiatrii imeni S.S. Korsakova, 119(12. Vyp. 2), 43–50. https://doi.org/10.17116/jnevro201911912243

Kuriakose, D., & Xiao, Z. (2020). Pathophysiology and Treatment of Stroke: Present Status and Future Perspectives. International journal of molecular sciences, 21(20), 7609. https://doi.org/10.3390/ijms21207609

Lee, J. H., Choi, I. R., & Choi, H. S. (2020). Immediate Effects of Ankle-Foot Orthosis Using Wire on Static Balance of Patients with Stroke with Foot Drop: A Cross-Over Study. Healthcare (Basel, Switzerland), 8(2), 116. https://doi.org/10.3390/healthcare8020116

Luger, T., Seibt, R., Cobb, T. J., Rieger, M. A., & Steinhilber, B. (2019). Influence of a passive lower-limb exoskeleton during simulated industrial work tasks on physical load, upper body posture, postural control and discomfort. Applied ergonomics, 80, 152–160. https://doi.org/10.1016/j.apergo.2019.05.018

Meseguer-Henarejos, A. B., Rubio-Aparicio, M., López-Pina, J. A., Carles-Hernández, R., & Gómez-Conesa, A. (2019). Characteristics that affect score reliability in the Berg Balance Scale: a meta-analytic reliability generalization study. European journal of physical and rehabilitation medicine, 55(5), 570–584. https://doi.org/10.23736/S1973-9087.19.05363-2

Ramos-Lima, M. J. M., Brasileiro, I. C., Lima, T. L., & Braga-Neto, P. (2018). Quality of life after stroke: impact of clinical and sociodemographic factors. Clinics (Sao Paulo, Brazil), 73, e418. https://doi.org/10.6061/clinics/2017/e418

Sinno, S., Dumas, G., Mallinson, A., Najem, F., Abouchacra, K. S., Nashner, L., & Perrin, P. (2021). Changes in the Sensory Weighting Strategies in Balance Control Throughout Maturation in Children. Journal of the American Academy of Audiology, 32(2), 122–136. https://doi.org/10.1055/s-0040-1718706

Smith, M. G., & Patritti, B. L. (2022). Minimal clinically important difference of the gait assessment and intervention tool for adults with stroke. Gait & posture, 91, 212–215. https://doi.org/10.1016/j.gaitpost.2021.10.041

Totah, D., Menon, M., Jones-Hershinow, C., Barton, K., & Gates, D. H. (2019). The impact of ankle-foot orthosis stiffness on gait: A systematic literature review. Gait & posture, 69, 101–111. https://doi.org/10.1016/j.gaitpost.2019.01.020

Tyson, S. F., & Kent, R. M. (2013). Effects of an ankle-foot orthosis on balance and walking after stroke: a systematic review and pooled meta-analysis. Archives of physical medicine and rehabilitation, 94(7), 1377–1385. https://doi.org/10.1016/j.apmr.2012.12.025

Visvanathan, A., Mead, G., Dennis, M.,Whiteley, W., Doubal, F., & Lawton, J. (2019). Maintaining hope after a disabling stroke: A longitudinal qualitative study of patients' experiences, views, information needs and approaches towards making treatment decisions. PloS one, 14(9), e0222500. https://doi.org/10.1371/journal.pone.0222500

Wang, C., Goel, R., Rahemi, H., Zhang, Q., Lepow, B., & Najafi, B. (2019). Effectiveness of Daily Use of Bilateral Custom-Made Ankle-Foot Orthoses on Balance, Fear of Falling, and Physical Activity in Older Adults: A Randomized Controlled Trial. Gerontology, 65(3), 299–307. https://doi.org/10.1159/000494114

Yi, Y., Ding, L., Wen, H., Wu, J., Makimoto, K., & Liao, X. (2020). Is Barthel Index Suitable for Assessing Activities of Daily Living in Patients With Dementia?. Frontiers in psychiatry, 11, 282. https://doi.org/10.3389/fpsyt.2020.00282

Zamysłowska-Szmytke, E., Janc, M., Ławnicki, K., & Śliwińska-Kowalska, M. (2022). Zastosowanie posturografii dla oceny układu równowagi dla potrzeb medycyny pracy [Use of the

posturography in balance system evaluation in occupational medicine]. Medycyna pracy, 73(2), 143–150. https://doi.org/10.13075/mp.5893.01164