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Development of Foldable Motorized Walker for Stability and Balancing

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ABSTRACT: The number of elderly people in Malaysia is gradually increasing as the population ages. These elderly people, particularly those suffering from disease-related mobility issues, are finding it increasingly difficult to walk as their physical abilities deteriorate. For children and teens who need help walking, walkers are designed especially for the needs and bodies of younger users. A walker, also known as a walking frame, is a device that helps disabled people maintain balance and stability while walking. Whether a child needs short-term assistance after an injury or illness or due to a long-term disability or medical condition, walkers are an excellent solution for safe and comfortable mobility. Older adults are often prescribed walking aids to encourage balance and mobility. Most walkers on the market are only able to be folded only once, causing huge sizes, so these walkers are not convenient for carrying, transportation and storage. The goal of this project is to design a foldable rollator walker into a virtually flat configuration for effective mobility-aid devices. Then, it is used to assess stability and balancing walking aid users based on the biomechanics principle. This foldable walker is a mobility-aid device that can be folded easily for transportation and reduce the user's physical power when lifting it. The combination of the walker and the motorized system would help the users to walk faster while using a walker. That way, this walker enables users to walk faster with less exhaustion. This walker also can be folded easily and it reduces the physical power when the users lift it.

1. INTRODUCTION

The number of elderly people in Malaysia is gradually increasing as the population ages. These elderly people, particularly those suffering from disease-related mobility issues, are finding it increasingly difficult to walk as their physical abilities deteriorate [1]. Aging, injury, and disease can cause users to lose their balance and put them at risk of falling. Invulnerable populations, fall-related injuries lead to decreased activity, lower quality of life, depression, social isolation, and mortality [2].

There are a variety of mobility aids, also called assistive technologies or assistive devices, which are used to help resolve mobility restrictions related to walking disabilities. Walkers designed specifically for the needs and bodies of younger users are a powerful boon for children and teens who need assistance walking. Whether a child needs short-term assistance after an injury or illness or due to a long-term disability or medical condition, anterior and posterior walkers are an excellent solution for safe and comfortable mobility. The walker is a very popular walking aid. To develop a walker, one must first learn the basics of walkers. A walker, also known as a walking frame, is a device used by people with disabilities who need extra help to maintain balance or stability while walking. This is usually due to age-related physical limitations. As we can see, the elderly make up the majority of those who use walkers because muscle mass decreases as one gets older. [3]. Mostly, people who have problems while walking use a walker as a walking aid. The three-sided frame surrounds the basic walker around the user. Users lift the frame and move it further in front of them before meeting it and repeating the process. The main purpose of using a walker is to improve walking performance and minimize the risk of falling [4].

This review paper aims to review studies on the most important and widely used summary parameters proposed in the literature, with a focus on clinical studies and discussion of the benefits and drawbacks of these parameters.

2. METHODS

To provide a comprehensive overview on gait stability, balance in gait, and walker summary literature search was performed from previous journals and articles which provided idea and information that needed for the project. By studying relevant literature, I would like to improve the previous project by implementing a foldable and motorized system to the walker in order to overcome the problem. I am also searching previous studies that related to my project on Google Scholar.

3. RESULTS

From my research, I focus on 3 things (Gait Stability, Balance in gait, and Walker) for my literature review based on the previous research. I study the parameters, methods, results of the previous analysis, and journals that can be used for the idea of analyzing the project.

Table 1: Summaries of research

	Findings
Gait Stability	The control of the body's center of mass (CoM) concerning the base of support is required for gait stability, which is defined as gait that does not cause falls (BoS, i.e. the area within an outline of all points on the body in contact with the support surface) [5]
	This “limit of stability” is determined by the biomechanics of the individual, the task requirements, and the type of surface on which the individual is standing [6]
	The position of the center of mass (CoM) or the extrapolated center of mass (XCoM) relative to the center of pressure (CoP) or the base of support (BoS) at any given time of the gait cycle determines the stability measurement. Sex, body posture, and limb direction all influence the position of the CoM [7]
	$XCoM = CoM' + \frac{vCoM}{\sqrt{\frac{g}{l}}}$ $CoP_{AP} = \frac{F_{AP} * CoP_V - M_{ML}}{F_V}$ $CoP_{ML} = \frac{F_{ML} * CoP_V - M_{AP}}{F_V}$
Balance in gate	The effects of Frenkel exercises on elderly men's coordination and balance were investigated, and the findings revealed that the Frenkel exercise program helped the elderly men improve their coordination and balance. [8]. Static Balance – Frenkel Exercise Dynamic Balance – Aerobic Exercise
	Gait disorders are common, contribute significantly to morbidity through falls, and may provide clues to diseases affecting all parts of the nervous system, making gait analysis one of the most complex and high-yield aspects of the neurologic examination. [9]
	Physical activity can lower overall morbidity and mortality by 30% to 50%. Leg strength and balance training are two of the most effective ways to reduce the risk of falling. [10]
Walker	Increase the support base and control the center of gravity of the user/walker system are two strategies used to enhance the standard walker and reduce the risk of falling. [3]
	A wheeled walker can help you avoid falling by providing more support than a walking stick. [11]
	The gait symmetry of the subjects who use conventional walkers or motorized walkers is better than those who walk alone. While using the motorized walker, also the subjects' stride and gait changed with haptic speed increases, stride and length also increases [12]

Table 2: Summaries of Literature Review

Journal/ Article	Method	Finding/Result
[13]	1. **Semiquantitative methods** **(**the *estimation* of their approximate concentrations) of gait assessment can be used for diagnostic purposes (for example, spinal tap testing when normal pressure hydrocephalus is suspected) and to evaluate treatment 2. **The timed up and go (TUG) test** is where it	1. Gait disorders can be caused by a variety of factors, including neurological conditions (such as sensory or motor impairments), orthopedic issues (for example, osteoarthritis and skeletal abnormalities), and medical problems (for

	refers to the time it takes for a patient to stand up from a chair with armrests, walk 3 meters (using a usual walker if necessary), turn around, walk backward and sit down. It is a simple assessment method used to assess the risk of falls in elderly patients	example, heart failure, respiratory insufficiency, peripheral arterial occlusive disease, and obesity). 2. Gait impairments can have a significant impact on one's quality of life and limit one's independence. 3. Problems with balance and gait can be signs of falls, and falls are the leading cause of serious injuries in the elderly. 4. I found in this journal the gait parameters for clinical examination, general precautions to avoid falls and injuries caused by falls, and risk factors for falls.
[14]	1.The biomechanics – kinematic, kinetic, and spatiotemporal features of rollator supported gait differ from unsupported gait in older persons 2. Evaluation of kinematic gait parameters – joint angles, gait phases or spatiotemporal features – or kinetic gait parameters – ground reaction force or joint moments of rollator supported gait 3. Participants aged 65 years or older.	1. Patients with muscle weakness and balance disorders should use a walker to improve their postural stability. 2. Stride length increases due to the use of the walker.
[12]	1. Used the VICON motion capture system to collect Postural spatio-temporary and gait data	1. In terms of gait symmetry, compared with conventional

	from six Parkinson's Disease subjects in three separate circumstances of manual gait aids: none (without walking aid), a usual rolling walker, and a motorized walker with three-speed levels: low (32 to 52 cms^{-1}), medium (52 to 72 cm^{-1}), and high (72 to 96 cm^{-1}). 2. To determine the importance of the gait modifications, statistical analysis was applied to the extracted gait features, and the asymmetry index was used to examine the bilateral coordination of locomotion.	walkers and motorized walkers, the test subjects performed better when walking than without walkers. 2. When using a motorized walker that prompts a speed higher than the mid-speed range, the subject's walking speed is faster and stride height and length are increased. 3. The stride height and length increase in tandem with the cueing speed. The subjects have the shortest stride height and the slowest cueing speed (SH: 14.52 ± 4.09 cm) and shortest stride length (SL: 49.72 ± 12.58 cm). When the cueing speed is the highest, the subjects stride height is also the highest (SH: 21.08 ± 2.97 cm) and length (SL: 74.76 ± 12.11 cm) 4. More symmetry in bilateral locomotion suggests that the subjects' balance will improve, lowering the risk of falling. The motorized walker can be used as a gait training device in rehabilitation.
[15]	1. The 102 healthy older adults (52 females and 50 males) were recruited through a newspaper	1. Participants who have better performance of relative muscle,

	advertisement, with an average BMI of 27 (SD = 3.6) and an average age of 72 years (SD = 4.5 years). A minimum age of 65 years was required, as well as the ability to walk for 10 minutes without assistance. 2. The study was divided into 10 factors outcome measures: pain, balance, strength and gender, physical activity, cognition, proprioception, mental health, Osteoarthritis and prosthesis, BMI, and peripheral sensation.	such as men, walk more steadily. 2. Men walk more steadily than women when it comes to the primary analysis' stability measures. This could be one of the reasons why women have a higher risk of falling.

1.1. Gait Stability

Gait stability is the ability to keep one's body balanced and coordinated while walking. Gait stability is also known as gait that does not cause falls, necessitates control of the body's center of mass (CoM) concerning the base of support (BoS, i.e. the area enclosed by an outline of all body points in contact with the support surface) [5]. This "limit of stability" is determined by the biomechanics of the individual, the individual's task requirements, as well as the type of surface on which he or she is standing. The BoS is the gait is formed by the feet that are in contact with the ground at any given time. In this respect, quadrupeds clearly outperform bipeds. However, quadruped and bipedal gait have many common spinal nerve control mechanisms, and the limb movement coordination of limbs and quadrupeds is similar during walking [5]. Biomechanical gait stability parameters have been used to assess the balance and gait stability of the elderly and/or gait disorders and/or persons with disabilities.
A stable gait, in a broader sense, does not result in falls. Gait stability comes in a variety of forms. For example, during normal overground walking, deal with minor internal disturbances (such as neuromuscular noise) and external disturbances (such as surface friction) or recover from larger disturbances (such as trip or slippage) [15]

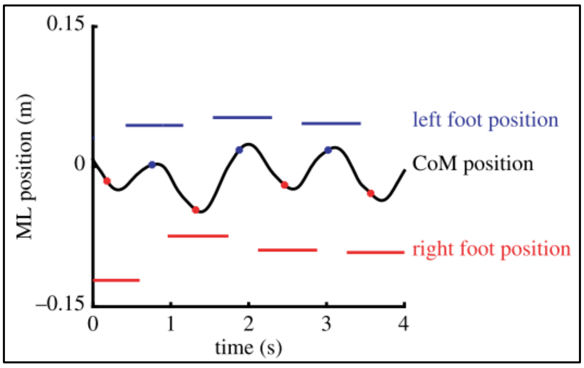

Figure 1: During normal gait, an example of mediolateral CoM motion and foot placements [5].

According to [7], the current study's stability measures were based on the position of the center of mass (CoM) or extrapolated center of mass (XCoM) relative to the center of pressure (CoP) or the base of support (BoS) at a specific point in the gait cycle (e.g., double support or heel strike). The position of the CoM is determined by sex, body posture, and limb direction. XCoM considers the position and speed of the CoM when determining the requirements for gait stability. The Hof equation was used to calculate the XCoM. [16][17].

$$XCoM = CoM' + \frac{vCoM}{\sqrt{\frac{g}{l}}}$$

Figure 2: Hof's equation [7]

CoM' represents CoM's ground projection, g = 9.81 m/s2 the CoM's velocity and l the maximum CoM's height. The CoP was used to detect balance during posture and throttle by measuring the centroid of pressure on the plantar surface of the foot. The CoP for both force plates was calculated using Sloot's equation [18].

$$(1)\quad CoP_{AP} = \frac{F_{AP} * CoP_V - M_{ML}}{F_V}$$

$$(2)\quad CoP_{ML} = \frac{F_{ML} * CoP_V - M_{AP}}{F_V}$$

Figure 3: Sloot's equation (1)(2) [7]

F represents the force in anterior-posterior (AP), medial-lateral (ML), and vertical (V) directions, M the moment of force, and CoPV the vertical distance between the surface of the treadmill belt and the force plates [18].

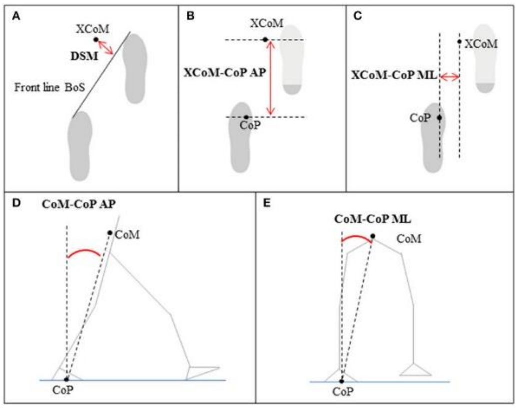

Figure 4: Measurement of gait stability based on the relative positions of CoM, XCoM, CoP, and BoS; (A) dynamic stability margin (DSM), (B,C) XCoM-CoP distance in the anterior-posterior (AP) and medial-lateral (ML) directions, and (D,E) CoM-CoP inclination angles in the AP and ML directions [7].

Gait analysis examines human walking in the oscillation phase, which begins when one foot is separated from the ground and moves forward until it returns to the ground and enters the support phase. Normal gait needs precise control of limb movements, posture, and muscle tone, which is a highly complex process involving the entire nervous system [9]. This can be supported by [19], all humans' gaits play an important role in their daily lives. As a result, of neurological, muscular, and/or osteoarticular deterioration, an individual's locomotion tends to deteriorate with age, affecting mental health and the ability to perform daily tasks.

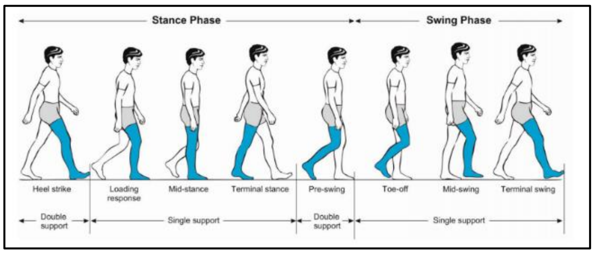

Figure 5: Diagram of a normal gait [13]

Table 3: Definition of terms in temporal and stride parameters

Terms	Definition
Step length	The distance from the ground contact point of one foot to the next contact point of the other foot, in meters.
Step period	The time or time spent in a step, in seconds.
Stride length	The distance from the initial contact of one foot to the subsequent initial contact of the same foot, in meters.
Stride period	Period of the initial contact of one foot to the following initial contact of the same foot, expressed in second, s.
Velocity	The rate of change of linear displacement along the direction of travel measured on one or more strides, in meters per second
Cadence	The walking rate of a person is expressed in steps per minute.

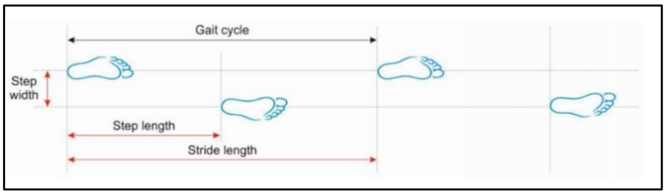

Figure 6: Basic terminology describing the gait cycle [13]

By referring to Figure 5 and Figure 6 above, the definition of each movement is as follows in Table 3 and Table 4.

Table 4: Definition of terms related to the gait cycle

Terms	Definition
Gait cycle	The time from the beginning of an event, usually the time from the initial contact of one foot to the time when the same event occurs again on the same foot.
Initial contact	Foot initially contacts the ground. Beginning of stance phase.
Midstance	Single support is used for the first half of the gait cycle, from 10% to 30%. When the opposite limb leaves the ground and the bodyweight is evenly distributed over the barefoot.
Terminal stance	In the second half from 30% to 50% of the gait cycle, single support is used. The time it takes for the heel to rise and the other limb to make contact with the ground.
Pre-swing	Period of final double support stance. From the moment of the first contact to the moment of toe-off
Initial swing	From 60 to 73 percent of the gait cycle, the first third of the swing phase.
Mid-swing	From 73 percent to 87 percent of the gait cycle, the middle third of the swing phase.
Terminal swing	The last third of the swing phase is 78% to 100% of the gait cycle. Time from the vertical tibia to first contact.
Double support	The time the feet are in contact with the ground. Occurs twice during the gait cycle (start and end of the stance phase).
Single support	The period when only one foot touches the ground. Equal to the swing phase of another limb.
Stance phase	When the foot touches the ground for the first time. 60% of the gait cycle is spent walking. • Heel-strike • Foot-flat • Midstance • Push-off

Swing phase	When the foot isn't in contact with the ground for an extended period. The gait cycle accounts for about 40% of the total. • Acceleration • Mid-swing • Deceleration

A previous study that was conducted in 2019 shows the gait stability of the elderly and its influencing factors. The purpose of this research is to determine the different influencing factors on gait stability. The 102 healthy older adults (52 females and 50 males) were recruited through a newspaper advertisement, with an average age of 72 years (SD = 4.5 years) and a mean BMI of 27 (SD = 3.6). The entry criteria are at least 65 years old, able to walk for 10 minutes without assistance. The study's outcome measures were divided into ten categories: pain, balance, strength and gender, physical activity, cognition, proprioception, mental health, Osteoarthritis and prosthesis, BMI, and peripheral sensation.

Table 5: Regression analysis is used to link the identified main components [15]

	Primary Analysis							
	LDS foot				**LDS trunk**			
	ST	DT	ST	DT	ST	DT	ST	DT
	beta	(p)	beta	(p)	beta	(p)	beta	(p)
Pain	0.155	0.101	0.214	0.030	-0.054	0.593	0.073	0.462
Balance	0.099	0.297	0.165	0.094	-0.162	0.113	-0.062	0.532
Strength & Gender	-0.318	0.001	-0.188	0.050	-0.331	0.001	-0.432	-0.001
Physical activity	-0.260	0.006	-0.197	0.040	-0.272	0.007	-0.103	0.287
Cognition	-0.049	0.597	-0.116	0.226	0.025	0.801	-0.012	0.902
Propreoception	-0.014	0.882	-0.141	0.144	-0.005	0.962	-0.006	0.950
Mental Health	0.105	0.257	-0.063	0.518	0.123	0.216	-0.113	0.255
Osteoarthritis/ prosthesis	-0.023	0.800	-0.032	0.734	0.135	0.175	0.273	0.006
BMI	0.191	0.043	0.172	0.075	0.098	0.327	-0.065	0.501
Periperal sensation	0.293	0.002	0.430	<0.001	-0.001	0.995	0.150	0.123
Adjusted R^2	0.255		0.260		0.150		0.233	
	Secondary Analysis							
	SD Stride length				**SD Stride time**			
	ST	DT	ST	DT	ST	DT	ST	DT
	beta	(p)	beta	(p)	beta	(p)	beta	(p)
Pain	-0.03	0.76	-0.04	0.700	0.24	0.02	0.20	0.06
Balance	0.25	0.02	-0.02	0.880	0.11	0.35	-0.01	0.97
Strength & Gender	0.10	0.34	0.11	0.277	-0.21	0.04	-0.11	0.31
Physical Activity	-0.13	0.24	-0.26	0.014	-0.26	0.01	-0.32	0.01
Cognition	0.11	0.29	0.28	0.007	-0.05	0.64	-0.02	0.83
Propreoception	0.15	0.16	-0.02	0.831	0.18	0.08	-0.02	0.86
Mental Health	-0.09	0.41	0.15	0.155	0.18	0.24	0.11	0.37
Osteoarthritis/ prothesis	0.06	0.54	-0.16	0.111	0.08	0.94	0.1	0.34
BMI	0.06	0.56	-0.11	0.275	0.14	0.17	-0.01	0.93
Periperal sensation	0.03	0.76	0.03	0.740	-0.03	0.76	0.22	0.04
Adjusted R^2	0.042		0.123		0.148		0.116	

Table 6: The correlations (Pearson's r) between each of the muscular fitness outcomes (S2SPeakVand S2SMeanV) and each of the gait stability and gait variability outcomes was separately assessed for male and female participants [15]

		Men (n = 49)		Women (n = 46)	
		$S2S_{PeakV}$ r (p)	$S2S_{MwV}$ r (p)	$S2S_{PeakV}$ r (p)	$S2S_{MwV}$ r (p)
LDS foot	ST	-0.327 (0.010)	-0.232 (0.052)	-0.096 (0.256)	-0.185 (0.102)
	DT	-0.296 (0.019)	-0.193 (0.092)	0.013 (0.465)	-0.056 (0.356)
LDS trunk	ST	0.017 (0.455)	0.126 (0.192)	-0.094 (0.259)	-0.177 (0.111)
	DT	-0.207 (0.077)	-0.128 (0.191)	-0.129 (0.196)	-0.234 (0.059)
SD Stride length	ST	-0.237 (0.049)	-0.246 (0.043)	-0.179 (0.110)	-0.191 (0.094)
	DT	0.070 (0.314)	0.034 (0.408)	0.043 (0.386)	0.039 (0.397)
SD Stride time	ST	-0.099 (0.246)	-0.130 (0.183)	-0.363 (0.005)	-0.397 (0.002)
	DT	-0.109 (0.227)	-0.118 (0.200)	-0.201 (0.091)	-0.219 (0.072)

Next, Referring Table 5, shows the results of the principal components analysis. Table 6 shows that the identified principal components were linked using regression analyses. The findings indicate that men and participants with higher relative muscle performance walk more steadily. We found significant differences in gait stability between male and female participants. In terms of the primary analysis' stability measures, men walk more steadily than women. This could be one of the reasons why women are more prone to falling. In single-task and dual-task walking, gait stability and variability are also highly affected by physical activity. This finding is consistent with wide evidence of the benefits of regular physical activity to the improvement and maintenance of the condition of older adults and their quality of life in connection with mental and physical health. The participant's ability to recover from small disturbances (measured by the largest Lyapunov exponent) seems to be related to (1) gender and muscular fitness, (2) the amount of physical activity the participant spends each week, and (3) peripheral sensation (mechanical And vibration detection threshold), and (4) pain state. Balance, proprioception, cognition, and mental health all had no or minor effects. Since the explained variance is still very low, more relevant factors may not have been noticed.

1.2. Balance in Gait

Balance is needed to maintain a position, responding to voluntary movements and also responding to external disturbances [20]. The center of mass of an individual must remain within the changing base of support to maintain balance. Balance is also an important consideration in the health of the elderly subject. Falls in the elderly population become more common as they get older, and these falls are linked to significant morbidity and mortality. Balance can be divided into 2: static balance and dynamic balance. Static balance happens when the object's center of gravity is on the rotation axis, whereas dynamic balancing happens when the rotation produces neither centripetal force nor pairs. Between the ages of 65 and 69, 13 percent of adults self-report imbalance, and this proportion rises to 46 percent in those aged 85 and older. Similarly, it is estimated that 35 percent of community-dwelling 70-year-olds and up have gait disorders. [20]

According to [21], balance problems are common among the elderly, and they are a leading cause of falls in this group. This can be supported by [20], The falls are linked to significant morbidity and death of the elderly: they constitute 55.8% of the accidental deaths, the most common cause of accidental death, and non-fatal accidental injury in the elderly 65 and older. Gait disorders are a major source of fall-related morbidity and have the capacity to identify nervous system diseases in every section of the body, so the examination of gait is one of the most important and broad components of a neurologic examination. They are linked to a higher risk of morbidity and mortality, as well as a lower level of function. Physical activity can lower overall mortality and morbidity by 30% to 50% [10]. Leg strength training and balance training, in particular, have been identified as effective methods for reducing the risk of falling. Balance, on the other hand, is the foundation of being able to stand upright and move around, so balance training should be a big part of fall prevention. Almost all studies that look into The risk of falls in older people conclude that physical exercise, even recreational sports, can help you maintain your balance and avoid falls.

Gait disturbances caused by Sensory deficits (polyneuropathy, bilateral vestibular disease, visual impairment), neurodegenerative diseases (Parkinson's disease, cerebellar ataxia, dementia), vascular encephalopathy, normal pressure hydrocephalus (NPH), and gait Nervousness is common in the elderly [20]. Closing the eyes can exacerbate the instability of polyneuropathy gait, which is characterized by loss of ankle reflex. Unstable gait on dark or uneven surfaces is a sign of bilateral vestibulopathy, as is oscillopsia. Visually impaired gait is unsteady, particularly on uneven ground. Parkinsonism is characterized by a hypokinetic gait and a reduced ability to multitask. With ataxia of the limbs, the cerebellar gait is ataxic. Slow gait, a higher risk of falling, impaired spatial orientation, and a reduced ability to multitask are all symptoms of dementia. Vascular gait is defined by a "frontal gait" pattern that includes small steps, a broad-based gait, and a normal arm swing. When compared to healthy people, older people with frontal gait disorders walked slower, had shorter stride length, lower cadence, a wider support base, and spent more time in a double support stance. Apraxic gait is a feature of NPH. Finally, anxious gait is characterized by broad-based gait, improvement with distraction, and normal dual-tasking ability, and is sometimes classified as psychogenic gait. Furthermore, older people frequently adopt a "cautious" gait pattern, which includes slower walking speeds, shorter step lengths, and more variability in step timing. This adaptation to the gait is more visible on irregular surfaces than at levels and can be used to increase the stability of head and pelvic in older adults.

Table 7 below summarizes these findings. Changes in gait can partially be attributed to older adults having a reduced walking speed, increased anterior pelvic tilt, and decreased peak plantar flexion. As a result, hip flexor contractures and plantar-flexor strength deficits may affect gait in elderly people.

Table 7: Gait Disturbance Patterns in the Elderly [20]

Type of Gait Disturbance	Characteristics
Polyneuropathic	Unsteady, worse with eye closure
Bilateral vestibulopathic	Unsteady in dark and on uneven surfaces
Visually impaired	Unsteady, worse on uneven surfaces

Parkinsonian	Hypokinetic, decreased dual-tasking ability while walking
Cerebellar	Ataxic
Dementing	Slow, increase falls, decreased dual-tasking ability while walking, impaired spatial orientation
Vascular encephalopathic	Small steps, broad-base, normal arm swing
Normal Pressure Hydrocephalus	Apraxic
Anxious/ psychogenic	Broad-based, improved with distraction, includes “fear of falling”
Cautious	Slow, reduced step length, increased variability in step timing

There is some evidence that exercise can help the elderly improve their balance. Different types of exercise, such as Pilates, stair climbing, vibration training, and dancing, have all been studied. These studies found that balance has improved significantly and show that physical exercise reduces the risk of falls. Because the majority of them focus on only one type of exercise or one type of balance (static, dynamic, or postural control), it's difficult to say which type of physical activity is the most beneficial. Based on, Another study looked at the eight weeks of Frenkel exercise have an impact on the coordination and balance of the elderly. The results show that the Frenkel exercise program can effectively improve the coordination and balance of the elderly. Frenkel exercise appears to become a useful exercise technique that improves balance and coordination and reduces the risk of falls and related treatment costs. The results of resistance and aerobic training on balance were studied, and the results show that both exercises can improve balance. Another study looked at the impact of aerobic exercise and balance exercise on the balance of elderly women, it is found that aerobic exercise and balance exercise programs have a significant impact to improve the balance of elderly women.
There are few studies on Frenkel balance exercises designed to improve balance, but quantitative research shows that they are effective for static balance. Aerobic exercises, on the other hand, have long been thought can effectively achieve dynamic balance, although the impact of this exercise on static balance has received less attention.

Figure 7: Frenkel exercise [22]


Figure 8: Aerobic exercise [23]

1.3. Walker

A walker frame is a metal frame with small wheels or rubber-tipped feet that is used to support disabled or infirm people while walking. Walkers are commonly used by elderly people who have general weakness, difficulty bearing weight on their lower limbs, poor balance, or other incapacitating conditions. According to [3], increase the support base and control the center of gravity of the user/walker system are two strategies used to improve the standard walker and reduce falls. This claim that the device should be easy for the elderly to use and maintain images of current standard mobile assistive devices to minimize the negative stigma associated with the use of assistive devices [3]. Before designing a walker, We must consider the user's gait disabilities on a sensory and cognitive level, as well as the user's safety, comfort, and ease of use [19].
Walking aids with three or more legs and built-in handgrips, two or more of which have wheels, that provide support while walking are known as rollator or a wheeled walker. They should also have a seat to sit on when they need to rest. A wheeled walker can help you avoid falling by providing more support than a walking stick [11].

Table 8: Type of walker [3]

Type	Standard	2 Wheels	3 Wheels	4 Wheels
Image				
Height (m)	30.4-37.4	32-39	34-38	34-38
Footprint (in.)	Depth: 16.5-18 Width: 21-23	Depth: 15-19.5 Width: 21-27	Depth: 23-28 Width: 21-27	Depth: 23-28.5 Width: 23-28
Weight Capacity (lb.)	250-300	250-300	250-300	250-300
Weight (lb.)	5-9	6-11	9-17	9-23
Cost	$49-99	$58-102	$85-122	$69-399

For example, motorized walker. A motorized walker is a combination of a walker with a motorized system. Motorized system is used to enable the walker moves faster and make the user feel less exhaustion when use a walker. According to [12], Depending on the user's preferences, the motorized walker was set up to move forward and turn at various speeds. The user grips the handles and receives a haptic cue from the walker's automatic movement when using it which the user can move and turn at a predetermined speed.

Figure 9: Motorized walker [12]

A previous study conducted in 2018 shows gait research on subjects with Parkinson's disease, using haptic cues from motorized walkers [12]. Figure 9 shows the motorized walker that has been used in this study. For the method of the study, they used the VICON motion capture system to collect postural spatio-temporary and gait data from six Parkingson's Disease subjects in three separate circumstances of manual gait aids: none (without walking aid), a usual rolling walker, and a motorised walker with three speed levels: low (32 to 52 cms^{-1}), medium (52 to 72 cm^{-1}), and high (72 to 96 cm^{-1}). It also employs the asymmetry index to assess the movement's bilateral coordination, as well as to determine the significance of gait modification, statistical analysis of the extracted gait features was performed. Table 9 shows the terminology that has been used in this study.

By referring to Table 10, it shows the mean and standard deviation of Parkinson's disease gait parameters. Depends on the mobility of PD patients, the configuration parameters can be changed. They discovered that as the increase in cueing speed, also the increase in stride height and length as well. As the cueing speed increases, the height and length of the stride increase as well. The subjects have the shortest stride height and the slowest cueing speed. (SH: 14.52 ± 4.09 cm) and shortest stride length (SL : 49.72 ± 12.58 cm). The subjects have the highest stride height when cueing is at its fastest (SH: 21.08 ± 2.97 cm) and length (SL : 74.76 ± 12.11 cm)

Table 9: Terminology [12]

Terminology	Definition
GCT	Gait Cycle Time
SW	Swing Time
ST	Stance Time
DS	Double Support
IDS	Initial Double Support
TDS	Terminal Double Support
SH	Step Height
SL	Step Length

Table 10: Standard deviation and mean of gait parameter for Parkinson's disease patient (PD) subjects are at low (ml), medium (mm) and high (MH) speed prompts without assistance (c), traditional walking aids (w) and motorized walking aids (m) [12].

Gait Parameters (Unit)	c	w	m		
			ml	mm	mh
GCT (s)	1.29 ± 0.25	1.34 ± 0.21	1.68 ± 0.28	1.4 ± 0.2	1.31 ± 0.13
SW (s)	0.35 ± 0.05	0.39 ± 0.06	0.43 ± 0.10	0.38 ± 0.06	0.38 ± 0.06
ST (s)	0.94 ± 0.22	0.95 ± 0.2	1.25 ± 0.28	1.02 ± 0.17	0.94 ± 0.1
IDS (s)	0.24 ± 0.69	0.24 ± 0.11	0.28 ± 0.14	0.22 ± 0.01	0.21 ± 0.06
TDS (s)	0.22 ± 0.03	0.22 ± 0.12	0.25 ± 0.13	0.21 ± 0.13	0.21 ± 0.05
SL (cm)	92.98 ± 1.24	70.61 ± 27.70	49.72 ± 12.58	68.59 ± 11.86	74.76 ± 12.11
SH (cm)	21.19 ± 3.14	20.78 ± 3.40	14.52 ± 4.09	19.02 ± 3.31	21.08 ± 2.97
Vel (cm/s)	75.28 ± 12.99	65.89 ± 17.36	29.24 ± 7.94	52.80 ± 10.56	67.33 ± 11.67

4. CONCLUSION

This review paper aims to review studies on the most important and widely used summary parameters proposed in the literature, with a focus on clinical studies and discussion of the benefits and drawbacks of these parameters. All that is stated have been discussed in this review paper. In this review paper, I have elaborated mainly about gait stability, balance in gate and walker. The comparison of the related research was covered all the method is to help those who have a problem while walking. I am also able to make some suggestions to make an improvement of my project and consider the suitable features of the project. So, this study will focus on one of the methods which to control walker by using 12V high torque dc motor and implementing motorized system to the walker. Based on the research that i made, there is an advantage by implementing motorized system that the gait symmetry performance of the test subjects walked better with conventional walkers and motorized walkers than without using walkers [12]. When using the motorised walker with a speed cue, subjects walked faster and had higher stride height and length. I observed that when the cueing speed increases, as a result, the length and height of the stride both increase. The faster the cueing speed, the longer the stride length. Other than that, I also studied the gait of a person that is unable to walk in the usual way and I also compared their gait with a normal gait. Also in this review paper, I elaborated terms that are commonly used in the gait phase such as stride length, stance phase, swing phase, acceleration and so on.

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