Functional reserve in functionally independent elderly persons: a calculation of gait speed and physiological cost

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Abstract

Aim: To analyze the behavior of functional reserve percentage (%FR) by gender in functional elderly persons, considering speed and the physiological cost of gait. *Methods:* A total of 53 self-reliant elderly persons, 40 of whom were women (age 69.4±4.7 years old; BMI 31.2±4.3 kg/m^2) and 13 of whom were men (age 70.8±7.2 years old; BMI 28.7±3.5 kg/m^2) participated in an observational and cross-sectional study. Participants were requested to walk at comfortable (CG) and maximum gait (MG). Both modalities were performed on a 70-meter elliptical circuit over three minutes. Distance and working heart rate were recorded for the corresponding calculation of average gait speed (AGS), physiological cost index (PCI) and used working heart rate percentage (% uWHR). With this information the FR% was determined by the percentage ratio with AGS, PCI and %uWHR under comfortable versus maximum demand walk conditions. *Results:* The association between %FR and AGS was significantly higher in males (p=0.017), reaching values of +-20% in most subjects. The physiological %FR for PCI was ≈30% in both men and women (p=0.156), while for % uWHR was ≈40% in females and ≈45% in males (p=0.131). *Conclusion:* AGS is a critical threshold functionality indicator to determine FR in functionally independent Chilean elderly persons.

Key words: Activities of Daily Living; Physical Fitness; Gait; Gender Characteristics; Aging.

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INTRODUCTION

In recent years the population statistics of developing countries have demonstrated an obvious demographic transition,[1] representing a significant increase in the number of people over 60 years. Projections indicate that by 2025 the percentages of this age group in most Latin American countries will reach double digits, climbing as high as 20% in countries such as Uruguay, Cuba and Chile.[2] In this context, academic reflections to support political decisions are vital to ensure the welfare and quality of life of elderly persons (EP) in the region.

Aging has been described as an extremely complex and multifactorial process,[3] which is characterized by continuous universal, progressive and irreversible changes, which in turn are conditioned by environmental, social, educational and economic factors.[4] In this scenario, the main indicator of quality of life and health in EP is functional capacity,[5] which in its various contexts requires the skilled and efficient expression of bipedal locomotion, considered to be a milestone human motor skill.[6]

Among the most documented manners of characterizing gait among EP is the measurement of the speed[7,8] and cost of locomotion.[6,9] In the context of the first measurement approach, the proposal of Bohannon,[8] which analyzes reference values and determinates for comfortable and maximum conditions, generating knowledge which allows a range of actions for functional expression, is worthy of note. Although it is based on analyzing the energy costs associated with gait, which is currently used as a *gold standard* outcome indicator,[9] this tool presents difficulties in terms of altering its performance and kinematic standard.[10] As an alternative, there are applicable proposals for the characterization of the physiological cost of gait through the behavior of heart rate (HR), with its considering percentage of use functioning as a translator of exercise intensity.[11] Additionally, MacGregor, in 1981, proposed the Physiological Cost Index (PCI) as a mixed indicator of the cost of locomotion by measuring the relationship between working HR and gait speed.[12] In this context, the main expression of dysfunctionality in EP is known as the "frailty syndrome," which is mainly associated with the systematic deterioration of muscle mass and strength with the consequent decrease in motor efficiency for the performance of gait, with speed representing a phenotypic indicator of frailty,[13] as well as being considered the sixth vital sign for the functional analysis of EP.[7]

Within this conceptual stage, literature describes thresholds or "acceptable minimums" for the expression of functionality in EP, highlighting for the purposes of this analysis torque muscle performance in the lower limbs and aerobic ability.[9] Additionally, Arnett et al. introduced the concept of Functional Reserve (FR),[14] which is defined as the difference between the maximum physical or mental capacity of a construct and the minimum necessary to perform daily functioning. In this regard, and considering the functional importance of the skilled and efficient expression of human movement, the principles included in the theory of continuous movement[15] state that the effective expression of functionality depends, throughout the life cycle, of a systematic difference between the maximum and current capacity of movement. It is worth noting that gender conditions the amplitude of FR, with higher rates of dependence among female EP.[16]

While research has been performed into FR in EP with different systemic morbidities, mainly related to oncological[17] and renal[18] conditions, there is little information on what happens in subjects experiencing successful aging. In this regard, EP test batteries have preferentially focused on maximum physical and physiological performance, regardless of the analysis of functional contexts for natural or comfortable conditions.

Given this background, the purpose of the present study is to evaluate the behavior of the percentage (%) of FR in autonomous EP, considering the difference between maximum gait (MG) versus comfortable gait (CG) conditions for indicators of speed and physiological cost.

METHODOLOGY

Participants

This observational and cross-temporality study comprised a non-probabilistic convenience sample of 53 EP (40 women) from four social clubs in the community of Talca, in Chile, who were contacted by personal interview between the researcher responsible and the directors of the clubs. Participants were recruited in January 2014, and were requested to attend morning measuring sessions (09:00-11:30 hours) in February of the same year wearing comfortable clothes and their usual shoes. These were performed in the facilities of the Universidad Católica del Maule (Maule Catholic University), and included all the tests required for this study. Before starting measurements, each of the participants signed an informed consent form which was approved by the Scientific Ethics Committee of the Universidad Católica del Maule *(N°2/2014).* Monitoring of the selection criteria and measurement of the study variables was performed by two physiotherapists with specific training in the field of gerontology. The inclusion criteria were controlled by applying the Examen de Medicina Preventiva del Adulto Mayor (Preventive Medicine for the Elderly Test) (EMPAM),[19] verifying an age between 60-75 years, specific anthropometry of normal weight or overweight (based on specific categorization for EP, according to BMI; using a DETECTO stadiometer, model 2392), autonomous in accordance with the Evaluación Funcional del Adulto Mayor-Chile, (Functional Evaluation of the Elderly-Chile) (EFAM-Chile) part A, a normal cognitive level (Short Mini Mental test ≥13 points) and without established depression (Yesavage Scale <5 points).[19] Subjects with decompensated chronic diseases, a risk of falls (positive Unipodal Station and *Timed up and Go* test results),[19] sequelae of neurological and cardiovascular diseases and moderate to severe pain in lower limbs (visual analogue scale >3 points) were excluded.

The demographic, anthropometric and functional characteristics are presented in Table 1.

Table 1. General characteristics of participants (N=53). Talca, Maule region, Chile, 2014.

Analysis Group	N	Age (years)	Weight (kilos)	Height (meters)	BMI (Kilos/m²)	EFAM A (points)	MMSE (points)	Educational level (years)
Total	53	69.8 ± 5.4	73.7 ± 11.9	1.55 ± 0.08	30.6 ± 4.3	51 ± 3	17.9 ± 1.3	10.1 ± 3.5
F	40	69.4 ± 4.7	72.0 ± 11.7	1.52 ± 0.05	31.2 ± 4.3	50 ± 3	17.9 ± 1.2	10.0 ± 3.5
M	13	70.8 ± 7.2	79.1 ± 11.4	1.66 ± 0.07	28.7 ± 3.5	51 ± 2	18.1 ± 1.2	10.4 ± 3.7
P value		*0,396*	*0.045*	*<0,001*	*0.050*	*0.353*	*0.712*	*0.724*

The table shows the demographic, anthropometric and functional variables of the participants. The values are expressed as mean ± 1 standard variation for each variable. F= female; M = male; n = number of participants per group; BMI = body mass index and EFAM A = Functional Evaluation of the Elderly-Part A

Procedure

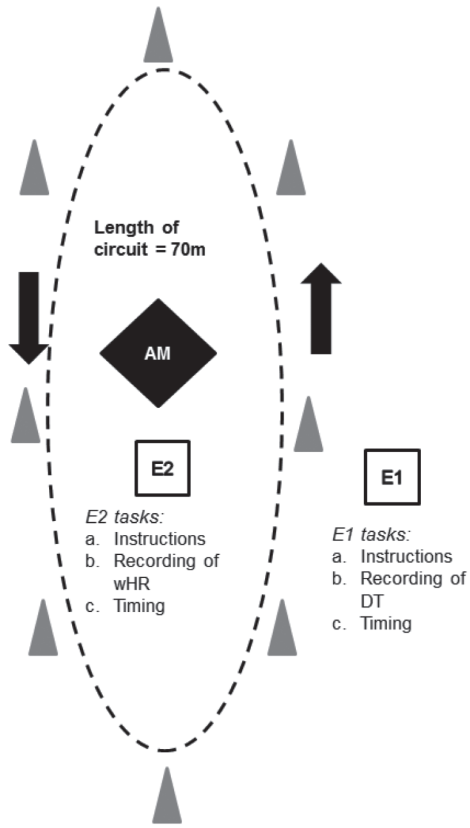
Basic anthropometric characterization included the measurement of body mass and height in a standing position, without shoes and retaining the lower edge of the orbits in the same plane as the external auditory canal (Frankfurt plane). Nutritional status was established in accordance with the specific categorizations for the elderly population.[19]

The evaluation in a physiological and perceptual state of rest was made after the elderly had remained in a supine position for five minutes, and measured HR (beats per minute, Polar® telemeter, FS3 GRY, USA/CAN), respiratory rate (RR, breathing cycles per minute, by visual observation), diastolic and systolic blood pressure (DBP and SBP, digital sphygmomanometer, Omron HEM-7114 model), pain (score 0-10, Visual Analog Scale) and the subjective sensation of fatigue (SSF, modified Borg Scale),[20] table 2. After this analysis, participants were asked to walk independently in two specific modalities. The first was entitled as comfortable gait (CG; habitual or natural speed), followed by verification of physiological and perceptual recovery in a sitting position (average rest time =3±3 minutes), and the second was considered as maximum gait (MG; speed of greatest or maximum demand). Both methods were performed for three minutes in an elliptical circuit of 70 meters comprised of a homogeneous surface (Figure 1). The time for the execution of gait has been established as sufficient to identify the steady physiological state of elderly persons in the community.[10]

Table 2. Physiological and perceived characteristics of participants at rest (N=53). Talca, Maule Region, Chile, 2014.

Analysis group	N	HR (beats/ min)	RR (v/min)	SBP (mm Hg)	DBP (mm Hg)	Pain (0-10)	SSF (0-10)
Total	53	69 ± 10	17 ± 4	139 ± 20	75 ± 10	0 (0-3)	0 (0-0)
F	40	69 ± 9	17 ± 4	136 ± 18	74 ± 9	0 (0-3)	0 (0-0)
M	13	69 ± 12	17 ± 3	151 ± 20	80 ± 11	0 (0-0)	0 (0-0)
P Value		*0,962*	*0.646*	*0.011*	*0.062*	*0.057*	*0.154*

The values are expressed as mean ± standard deviation for each variable. Pain and the subjective sensation of fatigue are median values with the minimum and maximum value obtained in parentheses. F= female; M = male; n = number of participants per group. HR = heart rate; RR = respiratory rate; SBP = systolic blood pressure; DBP = diastolic blood pressure; SSF = subjective sensation of fatigue; beats = beats; v = breaths and min = minute.



The dashed line represents the circuit. E1 = evaluator 1, E2 = evaluator 2, EP = participating elderly person, wHR = working Heart Rate and DT = distance travelled. The black arrows indicate the direction of movement and the grey triangles represent the cones marking the circuit. **Note:** marking not to scale.

Figure 1. Plan of elliptical circuit for performance of MG and CG.

Two evaluators (E1=evaluator 1; E2=evaluator 2) performed the measurement procedure. E1 recorded the distance traveled (DT; observation of markings every meter of the circuit), while E2 measured the working HR (wHR) immediately after the test. With this information, the behavior of speed and physiological cost for both types of gait was determined by the following formulas:

a) average gait speed (AGS):

AGS (m/s)=DT/180

Where DT is in meters and 180=seconds.

b) Physiological cost index (PCI)[12]:

PCI (b/m)=(wHR–bHR)/s

Where, wHR is in beats/minute; bHR in beats/minute and s = gait speed in meters/minute.

c) percentage of reserve heart rate used (RHRu%)[11]:

RHRu%=100*(wHR – bHR)/[(220 – age) - bHR]

Where age is in years, wHR in beats/minute and bHR in beats/minute.

Determination of Functional Reserve Percentage

FR was determined from the percentage relationship between the analysis indicator (AGS, PCI and RHRu%) at maximum gait (MG) versus comfortable gait (CG), modifying the proposal of *Hashidate & Uchiyama* in 2007.[21] In this context the overall formula was as follows:

%FR=100-[(CGP/MGP)*100]

Where FR%: percentage of functional reserve; CGP: comfortable gait performance; MGP: maximum gait performance. The performance indicators for the calculation of FR% associated with AGS, RHRu% and PCI were analyzed using the same measuring units as described above.

Statistical analysis

The normality of the analysis variables was performed using the Shapiro-Wilk test. The descriptive variables were analyzed by mean ± standard deviation and, in the case of calculations involving the gender of the primary study variables, was complemented with confidence intervals of 95% ($CI_{95\%}$). The comparison of the *AGS* and *PCI* by gender was calculated using the Student-t test for independent samples, while *RHRu%* was analyzed with the Mann Whitney U test. Comparison of the FR% of the speed and physiological cost of gait was analyzed using the Mann Whitney U test.

The level of statistical significance was established as $p<0.05$. Descriptive and inferential statistical analysis was performed using the *GraphPad Prism* software package version 5 (GraphPad Software Inc., San Diego, CA, USA).

RESULTS

The general characteristics of the participants described in table 1 show that the majority were aged from 65 to 75 years, irrespective of gender ($p=0.396$). The nutritional state of both groups was at the upper limits of normal weight ($p=0.050$). From a functional perspective, the subjects evaluated were all categorized as autonomous according to the EFAM-Chile, with similar scores for both genders ($p=0.353$). Furthermore, cognitive level was categorized as normal, while the level of education was classed as an incomplete high school education, with no difference between genders for either category.

The physiological and perceptual characteristics shown in table 2 comply with those declared in the selection criteria, with both groups displaying acceptable stability; although systolic blood pressure was significantly higher among men ($p=0.011$). Perceptions of pain and fatigue did not exceed mild, and were similar for both genders.

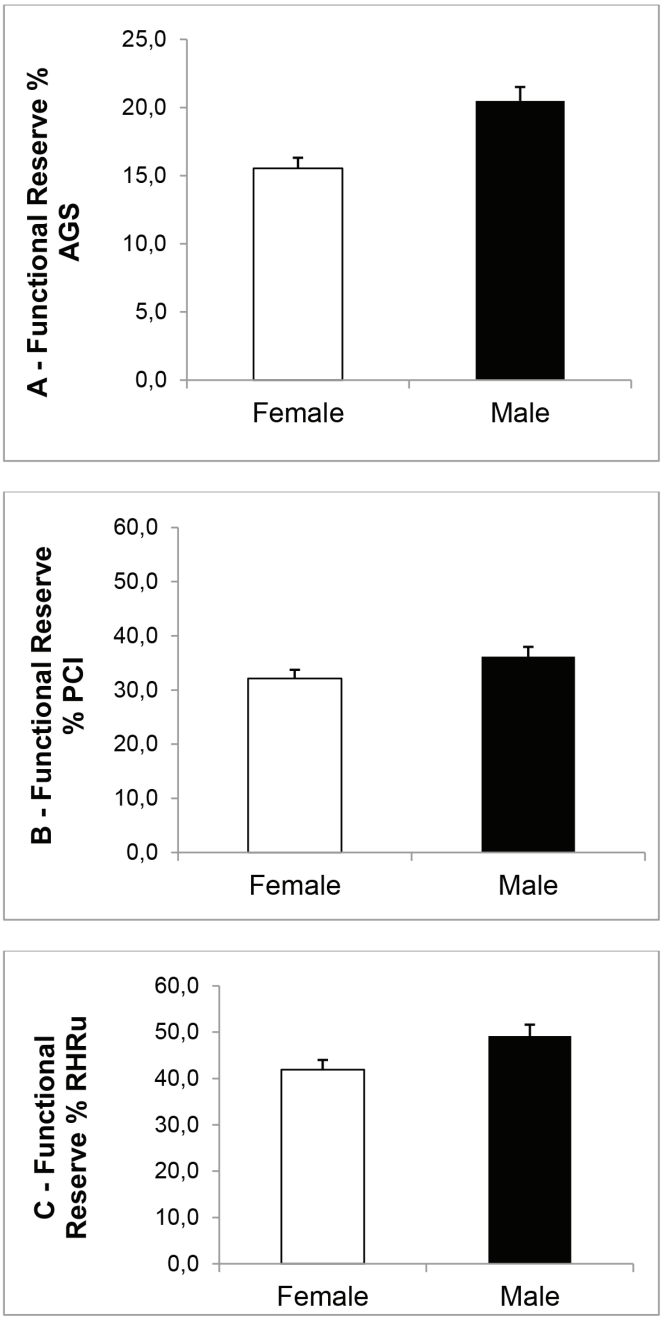
Table 3 shows the speed and physiological cost outcomes of CG and MG. AGS was significantly higher among males, for both comfortable ($p=0.027$) and maximum ($p<0.001$) gaits. When evaluating behavior by gender, cost of gait measured by PCI was significantly higher among women for both CG ($p=0.007$) and MG ($p=0.008$). The behavior of RHRu% did not vary between genders.

Table 3. Behavior of speed and physiological cost of comfortable and maximum gait (N=53).

Type		**Comfortable gait**			**Maximum gait**		
Analysis group	**N**	**AGS (m/s)**	**PCI (b/m)**	**URHR (%)**	**AGS (m/s)**	**PCI (b/m)**	**URHR (%)**
Total	53	1.16 ± 0.16	0.35 ± 0.17	29.8 ± 13.9	1.38 ± 0.20	0.50 ± 0.20	50,7 ± 19,9
F	40	1.13 ± 0.15	0.38 ± 0.18	31.7 ± 14.7	1.33 ± 0.18	0.53 ± 0.20	52,2 ± 20,9
M	13	1.24 ± 0.18	0.24 ± 0.12	24.1 ± 8.8	1.54 ± 0.19	0.38 ± 0.14	45,8 ± 16,0
P value		0.027	0..007	0.061	*p*<0,001	0.008	0.197

The values are expressed as mean ± standard deviation for each variable. F= female; M = male; n = number of participants per group; AGS = mean gait speed; PCI = physiological cost index and %uRHR = used reserve heart rate.

Table 4 and Figure 2 summarize FR% based on the speed and physiological cost of locomotion. In this regard, FR% associated with AGS is significantly higher among males, with a value of 20.5±5% versus 15.5±6% in women (p=0.017), Figure 2A. In terms of physiological FR, this was close to 30% for the PCI for both men (mean=36.2±12%) and women (mean=32.1±20%), (figure 2B, p=0.156). The wHR% was close to 40% for both genders, with specific percentages of 41.9±18% for women and 49.1±10% for men (figure 2C, p=0.131).



The bars represent the mean FC by gender with $CI_{95\%}$, n = 53 (female, n = 40; male n = 13). **A.** Average gate speed (AGS). **B.** Physiological cost index (PCI). **C.** Percentage of reserve heart rate used (RHRu%). The black bars represent men and the white bars represent women. *p<0.05.

Figure 2. Behavior of FR according to gender. Talca, Maule region, Chile, 2014.

Table 4. Behavior of Functional Reserve for speed and physiological cost of gait (N=53). Talca, Maule region, Chile, 2014.

% FR	Total (n = 53)		Male (n = 13)		Female (n = 40)		Differences in means		*P value*
	X ± SD	CI 95%	X ± SD	CI 95%	X ± SD	CI 95%	X ± SD	CI 95%	
AGS (%)	16.8 ± 6	15.1-18.5	20.5 ± 5	17.3-23.5	15.5 ± 6	13.6-17.5	4.9 ± 2	1.2-8.7	0.017
PCI (%)	33.1 ± 18	28.1-38.2	36.2 ± 12	29.2-43.2	32.1 ± 20	25.7-38.5	4.1 ± 6	-7.8-15.8	0.156
%URHR (%)	43.7 ± 17	39.1-48.3	49.1 ± 10	42.9-55.5	41.9 ± 18	36.1-47.8	7.2 ± 5	-3.4-18	0.131

X = mean; SD = standard deviation; CI 95% = confidence interval of 95%. FR% = functional reserve percentage; AGS = FR% associated with average gait speed; PCI = FR% associated with physiological cost index; %uRHR = FR% associated with percentage of reserve heart rate used. The calculation of FR% considered the equation: FR% = 100-[(CGP/MGP)*100

DISCUSSION

The purpose of the present study was to analyze the FR% for the performance of gait in conditions of maximum versus comfortable demand. In this sense, the main findings focus on the determination of physiological cost and speed in autonomous EP.

Average gait speed

The concept of measuring speed during the execution of CG has been much studied.[8,22-25] The values obtained in the present study are inconsistent with previous findings, which report both inferoir[8,22,23] and superior results.[24,25] This situation can be explained by the expression of confounding factors, which are based on the demographic and anthropometric aspects specific to each sample, which emerge from the use of diverse populations, such as Caucasian,[8,23,24] Asian[22] and Latin American.[25] Furthermore, indicating the importance of the measuring methodology, a high level of confidence has been demonstrated for the use of a straight unidirectional 10 meter track,[26] which is considered a sufficient distance for the expression of gait in normal execution conditions.[27] In such context, the justification of the use of an elliptical track 70 meters in length in the present study was based on clinometric factors, as it reduces the neuromotor component in accelerations and decelerations,[28] in addition to ensuring sufficient time and distance to extrapolate advanced activities of daily living[10,29] such as transport to community centers and health.

The AGS was greater among the male generation for both CG and MG (table 3). In this respect, Fritz *et al.* proposes that CG speed is systematically greater among men from the seventh decade of life onwards.[7] This specific behavior, associated with the temporal-spatial performance of gait, can be an inflection point for investigating further the apparent differences in gender documented for frailty[30] and functional dependency,[16] which are preferentially expressed among those undergoing in the process of aging. Meanwhile, previous studies have reported significantly higher maximum speed conditions than the values reported in this experiment.[8,22,23] In this context, the specific characteristics of the track and the timing used allow the EP to effectively achieve a steady gait conditions.[10,27,28]

The evaluation of FR through analysis of gait speed is notable for a lack of information. Hashidate & Uchiyama applied this concept in a Japanese study of EP using the *Timed Up and Go* (TUG) test. In comfortable versus maximum speed conditions, they found that the FR obtained using the TUG was significantly lower in dependent EP in activities of daily living,[21] although analysis by gender was not performed. It should be noted that while this proposal adopted a similar mathematical model to the present study, the test selected only considered functional contexts within the home such as moving toward the bathroom, kitchen or dining room.[29]

Considering the calculation of FR% by gender, a higher AGS was found among men (table 4, figure 2A), confirmed by the consistently superior performance among men in both maximum and comfortable conditions (Table 3). This finding has a multifactorial explanation related to functional walking capacity in EP, which focuses mainly on the state of muscle strength in the lower limbs.[31] Reid *et al.* established that the power of the musculature of the lower limbs depends on the magnitude of the angular velocity of execution, showing a systematic increase of expression in healthy EP versus a subsequent plateau at 90°/s among those with limited mobility,[32] a result that could be extrapolated to the capacity to achieve optimum gait speeds for functional performance.

In this scenario, the difference observed between the FR values obtained using the model of the present study (Table 4) could guide decision-making relating to functional diagnosis, since the results obtained over small distances could be extrapolated for activities within the home. Meanwhile, FR for activities outside a particular environmental context would have greater validity if a longer track was used. This approach needs to be complemented with the evaluation of the performance of the EP on tracks similar to that of the proposed methodology, considering uneven terrain or obstacles.[33]

Physiological cost of gait

The measurement of the physiological cost of gait is justified by its important role as an indicator of the central and peripheral muscle phenomena that result in changes to the metabolic demands of the system. Conley *et al.*, when evaluating the oxygen consumption of the knee extensor muscles, found that EP have around 50% of the oxidative capacity by muscle volume of younger subjects.[34] In this context, the importance of measuring FR associated with the physiological behavior of gait is based on changes in peripheral demand that could be indirectly translated by the behavior of vital signs. The relationship between gait speed and wHR as an indirect indicator of oxygen consumption in people has been previously documented.[35]

Physiological cost was higher among females for both types of gait analyzed (Table 3). This statement is consistent with the findings of previous studies.[14,35] Notwithstanding the above, little information is available relating to the execution of gait in a corridor, with this proposal being a pioneer in this respect. However, FR relating to the physiological cost of gait in maximum and comfortable conditions did not differ significantly by gender according to the PCI (table 4, figure 2B) and RHRu% (table 4, figure 2C). This situation can be explained primarily by the three-minute walking time used in this experience, which although described as ideal for reaching physiologically stationary states in autonomous EP,[10] is not sufficient to discriminate differences by gender in physiological overload based on aerobic metabolism.[23] Similarly, the behavior of SBP at rest in men (Table 2), which is categorized as an initial state of hypertension,[36] diminishes their physiological reserve. Notwithstanding the foregoing, the American Thoracic Society declared a resting SBP over 180 mm Hg as a relative contraindication for the execution of the six-minute walk test,[37] evidence that supports the decision to include this group in the present study of gait. In the context of the use of antihypertensive medications, while the relative frequencies of use were similar between genders (Table 5), the divergent SBP behavior could be explained by the low adherence to medication in males.[38]

Table 5. Main types of pharmacological treatment and percentage of sample using medication according to gender (N=53). Talca, Maule region, Chile, 2014.

Chronic Pathology	Pharmacological Treatment	Total % (n = 53)	F % (n = 40)	M % (n = 13)
AHT	Angiotensin II receptor antagonists	33.9 (18)	32.5 (13)	38.5 (5)
	Angiotensin converting enzyme inhibitors	28.3 (15)	25.0 (10)	38.5 (5)
	Dihydropyridine calcium channel blockers type	9.4 (5)	10.0 (4)	7.7 (1)
	Diuretics	7.5 (4)	10.0 (4)	0
DM2	Hypoglycemic agents	11.3 (6)	10.0 (4)	15.4 (2)
	Antihyperglycemic agents	7.5 (4)	10.0 (4)	0
HC	Statins for lowering cholesterol levels	37.7 (20)	45.0 (18)	15.4 (2)
COPD	Bronchodilators	5.7 (3)	7.5 (3)	0
P CVD	Antiplatelets	13.2 (7)	10.0 (4)	23.1 (3)
MS Pain	Analgesic inhibitors of prostaglandin synthesis	15.1 (8)	17.5 (7)	7.7 (1)

Values are shown in percentage (%) form with absolute frequency in parentheses. F= female; M = male; n = number of subjects. AHT = arterial hypertension; DM2 = type 2 diabetes mellitus; HC = hypercholesterolemia; COPD = chronic obstructive pulmonary disease; P CVD = prevention of cardiovascular disease; ME = musculoskeletal.

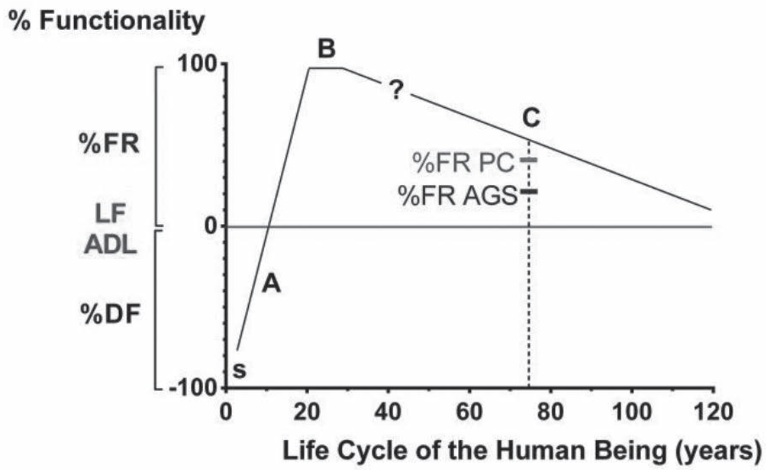
On the other hand, from a methodological point of view, the criteria for selection for participation of the EP in the sample was that given that their functional levels of autonomy were categorized as healthy aging (Table 1), this indicator may not be sensitive at this stage. Notwithstanding the foregoing, there was an emerging trend of greater physiological reserve in males (Figure 2B and C) for both variables, which could dialogue with the degree of comfortable speed achieved by this group, which is close to the optimum conditions reported.[6,7] It should be noted that the largest number of participants belonged to the female gender and the absence of categorization of the level of physical activity may be obvious sources of methodological bias for the extrapolation of these results, which are preliminary in nature. It is therefore planned to expand this research proposal with more balanced populations of EP in terms of gender, control of confounding variables and evaluation of heterogeneous factors from a demographic, anthropometric and functional perspective.

Projections

This is the first study that analyzes the behavior of FR associated with the speed and physiological cost of autonomous Chilean EP. The results presented could be considered as a framework for studies using similar methodology. In this scenario, gait has been found to be a predictor of functional loss,[39] and requires complex characterization that considers performance and the associated physiological costs. In this regard, Schrack et al. proposed that the energy loss of mobility in EP depends on various factors which are explained by biochemical processes that maintain homeostatic balance and allow the adaptability of movement based on energy conservation.[40] Thus, the projections of this study lie in its support of policies, mechanisms and the monitoring of processes with a public-health goal towards the relevant characterization of movement based on the relationship between maximum capacity and the need to engage in various functional contexts,[15] which we systematically describe as

FR based on speed,[21] muscle strength[9] and aerobic capacity[14] (figure 3). In addition, it not only focuses on scenarios of palliative care of dependent EP suffering from illness, but from a preventive perspective considers the risks of dysfunction by characterizing movement, determining the critical points or "thresholds" of functional expression,[9] and representing a timely intervention by considering environmental gait training as a real alternative for the prevention and treatment of specific disorders.[41]

Finally, the results of the present study show that speed is the earliest and most sensitive indicator for determining FR in autonomous Chilean EP living in the community.



Acquisition of skills for the development of functional gait during early life cycle, with a baseline (i) of independent march beginning during the first postnatal year. **B.** Maximum expression of functional gait considering the different systems employed. **C.** Functional reserve by age corresponding to the participants, highlighting the largest reserve by physiological cost versus speed. The question mark **(?)** reveals the lack of evidence for determining the timing and basis of ontogenetic divergence in physiological reserve contributions (≈30-40%) versus speed (≈15-20%) for the execution of independent motion during the advanced stages of the life cycle. FR% = Percentage of Functional Reserve; FL ADL = Functional Limit for Activities of Daily Living; DF% = Dysfunctional Percentage; FR% PC = Functional Reserve percentage associated with Physiological Cost; FR% AGS = Physical Reserve Percentage associated with Average Gait Speed.

Figure 3. Diagram of Functional Reserve of independent gait during the human life cycle. Talca, Maule region, Chile, 2014.

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