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Relationship between Morphofunctionality and Postural Control of Physically Active Older Women

Luenry Mendoza Montecino[1], Orlando Sanguino Salazar[2], Claudia Milena Suárez Trespalacios[3], Cristhian Alberto Bautista Rico[4]

Abstract

Introduction: Aging, as an entropy of life, implies the decrease of physical and morphological capacities in humans, affecting the functionality of postural, static and dynamic control, which generates a greater risk of falling. Objective: To relate morphofunctionality, postural control and cognitive status using new technologies. Materials and Methods: The study was cross-sectional and correlational. The sample size was 70 women, selected through simple random probability sampling. The evaluations were applied through the Montreal Cognitive Assessment, Baecke, height, body mass, hand grip strength, Chair Stand Test, postural control in static standing, open eyes and Timed up and go. Statistical data were analyzed using SPSS version 25 software for Windows. P = <0.05 was established by the Shapiro-Wilk and Levene tests for normality and homogeneity. Descriptive data were calculated by central tendency statistics (Mean, Standard Deviation) and the correlation between variables through Pearson's correlation coefficient. The results between the MoQ and Vel/AP were low with a Pearson r value of -0.239 and a sig. value (bilateral) = 0.046 and between the CST and TUG it was low, with the Pearson r value r value of -0.364 and a sig. value (bilateral) = 0.002). Conclusion: The morphofunctional and postural control relationship and the identification of the relationship between variables could be useful to attenuate functional losses in the population.

Keywords: *Aging; cognition; physical activity; strength; postural control.*

1. Introduction

Currently, humans are facing the phenomenon of demographic aging, morphological and physiological changes in the systems involved in balance. The contextualization of the topic allows us to understand how the changes affect functional abilities and how these are related to postural control, which is essential to develop the basic activities of daily living. The study contemplates novel and low-cost tools outside laboratories to measure postural control, in addition to providing information for the multidimensional evaluation and assessment of the functional status of the elderly, in such a way that they could be previously used within the designs of physical activity programs focused on preventing falls and thus contributing to active and healthy aging.

The population of older adults presents an accelerated growth, according to the WHO, (2022), the phenomenon occurs due to the increase in longevity and the decrease in the birth rate, these changes in the population pyramid have generated demographic aging at

[1] Universidad de Pamplona-Colombia, luenry.mendoza@unipamplona.edu.co, https://orcid.org/0000-0003-0365-7473
[2] Universidad de Pamplona-Colombia, orlando.sanguino@unipamplona.edu.co, https://orcid.org/0000-0002-5994-2479
[3] Universidad de Pamplona-Colombia, clmilena728@hotmail.com, https://orcid.org/0000-0002-9200-9883
[4] Universidad de Pamplona-Colombia, cristhian.bautista@unipamplona.edu.co, https://orcid.org/0000-0002-7674-321X

a global level. In this sense, the report presented by the UN, (2017), announced that the number of people over 60 years of age will double between 2017 and 2050. Likewise, statistics indicate that Colombia, Santander and Bucaramanga follow the upward trend observed globally (DANE, 2018).

The aging process brings with it multiple morphological and physiological changes in the nervous, musculoskeletal and sensory systems, involved in postural control; In addition, these changes are related to diseases and the increased risk of falling, affecting the development of basic activities of daily living. Falls mostly lead to dependency and substantially decrease the quality of life, since they lead to early prostration and finally to the death of the elderly (López & Izquierdo, 2006; de Jaeger, 2018).

The situation described above worries scientists and government representatives at the global and local levels due to the high costs represented by the burden on the health system to address the comorbidities of aging. For this reason, it is crucial to understand and know this phenomenon in order to look for mechanisms that allow active and healthy aging (Khan, 2019)

In essence, the importance of the topic as a corpus of study seeks alternatives that lead to attenuating the risk of falls in older adults; It is estimated that more than 600,000 people die annually from these events. Currently, this problem is positioned as the second cause of death, affecting women in greater proportion (WHO, 2021a).

Around this problem, there is a marked interest in knowing what is the relationship between morphofunctional decreases and postural control in the elderly, so that the information allows us to predict falls in the population, it should be noted that, despite the fact that the subject is relatively new, there are very interesting studies in this regard. However, in Colombia, we did not find studies examining the relationship between morphofunctional measures and postural control, in which the assessment of static postural control is instrumented with an advanced technology accelerometer, incorporated in a low-cost smartphone, outside of clinical laboratories; In addition, no multidimensional studies were found that integrate cognitive, anthropometric, strength, and static and dynamic postural control factors. Therefore, it was deemed appropriate to conduct this investigation.

With the purpose of relating the morphofunctionality, postural control and cognitive status of older adults aged 60-65 and 70-75 of the Wonderful Years Life Center of the city of Bucaramanga through the use of new technologies. Data analysis was applied to establish relationships based on cognitive, morphological and postural control variables, in such a way that they contribute to identifying the risk of falling in the population and therefore this enjoyment of active and healthy aging in society.

The study was chosen to be carried out with women because they are more likely to experience falls and because they belong to the fastest growing population group; In addition, it was established to have a defined segregation of women consecutively to avoid age differences with more or less than five years (60 - 65 and 70 - 75), which is why the 66-69 age group was excluded.

1.1 Problem statement

In the world, people age as an entropy of life itself, according to the World Health Organization (2022), the probability of living more than 60 years is due to biotechnological advances in health and public policies. The low birth rate and the increase in longevity have caused demographic aging at a global level, causing the phenomenon to advance at an unprecedented rate. The UN report (2017) indicated that the number of people in the world over the age of 60 will increase between 2017 and 2050, from 962.3 to 2080.5 million respectively. He also pointed out that Latin America and the Caribbean will be one of the regions that will face this phenomenon with the highest rates of aging, going from 76.0 to 198.2 million by mid-century.

According to the National Administrative Department of Statistics, (2018), projections show that the rate of increase of women over 60 years of age between 2021 and 2030 will go from 3,918,300 to 5,4671.35, in Santander from 190,664 to 263,092 and in Bucaramanga from 57,647 to 80,547 respectively. In terms of population by gender, there will be more elderly women than men in the country. In general terms, the situation described causes concern to the scientific community and representatives of government organizations, due to the high costs of the burden on the health system to address comorbidities related to loss of physical abilities and falls (Khan, 2019; WHO, 2022).

Worldwide, 37.3 million falls occur each year, and in the face of these events, older women are more susceptible to serious consequences, such as contusions, fractures, especially hip fractures, and head trauma (WHO, 2021a). In the United States of America, the health cost of treating falls amounts to US$ 50 million (Lohman et al., 2019). In Colombia, during the last 12 months, the total incidence of falls in the elderly population represented 31.9%, Falls in women progressively increased with age (Jaramillo et al., 2020).

In humans, aging entails a series of alterations that affect physical abilities and the development of ABVD according to López & Izquierdo (2015), after maturity their physical activity decreases as age advances and pathologies arise. There is also a relationship between physiological changes and exercise. For example, in the cardiovascular system, there is a reduction in the size of the heart, heart muscle, and muscle hair fibers. On a functional level, it reflects the decrease in muscle blood flow, stroke volume, and heart rate. In addition, it increases peripheral resistance and blood pressure after loading. In the respiratory system, changes are generated such as a decrease in lung elasticity and pulmonary capillaries; Functionality is affected by the increase in the work of breathing and the decrease between ventilation and perfusion.

Changes in the musculoskeletal and joint system are manifested in the decrease in muscle mass, the number of type II fibers, the size of motor units, the threshold of action potential and the articular connective tissue. There is even an increase in joint mechanical stress and a decrease in intervertebral fluids; At the functional level, there is also a decline in strength, power, stability, joint mobility and reduced height. In the skeletal system, bone density decreases, causing osteoporosis and the risk of fractures. In body composition, adiposity increases, which affects mobility to perform ABVD and increases the risk of comorbidity. (López & Izquierdo, 2015).

The central nervous system undergoes substantial changes. The density of the brain decreases by 30%, much of it gray matter, the decrease also occurs in the main neurotransmitters such as serotonin, acetylcholine and catecholamine which, in turn, are related to deficits in the domains for information processing and slowing down of motor function (Navaratnarajah & Jackson, 2017). An aging brain is predisposed to neurodegenerative pathologies and dementia (Cole et al., 2019).

The main changes in the visual system are manifested by a decrease in the density of the cornea, the deterioration of endothelial cells and an increase in the lens, in addition, the rods in the cones of the macula decrease and the structure of the optic nerve deteriorates (Grossniklaus et al., 2012). On a functional level, visual acuity, focus, visual perception, contrast sensitivity, and adaptation in the dark decrease. Among the most common eye diseases in older people are cataract and macula degradation, among others (Sturnieks et al., 2008).

Vestibular system changes arise with the decrease in otoliths located in the saccules and utricle, as well as the number of hair cells in the ampullary crests within the semicircular canals. It is estimated that the loss of hair cells in the crest is 40%, in the macules and saccule 25%, and in the utricle 20%. Type I and II hair cells lose an average area of 0.01 mm2 per decade (Zalewski, 2015).

In the somatosensory system, mechanoreceptors decrease, including cutaneous receptors at twilight of Pacini and Meissner; On a functional level, it decreases the perception of sensitivity of vibrations on the soles of the feet. (Shaffer & Harrison, 2007).

The relationship of multiple morphological and physiological changes in the CNS, musculoskeletal, somatosensory, visual and vestibular systems. They affect the function of postural, static and dynamic control, which generates a greater risk of falling (Lacour, 2016; Byra, 2020; Michalska et al., 2021).

As we age, physical and mental abilities decline, leading to a decline in cognitive function (Erickson et al., 2022), specifically affecting information processing capacity, memory, reasoning, and executive ability related to impaired static and dynamic postural control (Taylor et al., 2019).

Strength capacity declines, leading to poor performance in the upper and lower extremities and trunk muscles (Clark & Manini; 2012; Cruz-Jentoft et al., 2019). These impairments are associated with dynamic postural balance (Golubić et al., 2021).

The ability to maintain (static) balance in standing decreases in parallel with advancing age (Sheldon, 1963; Fernie et al., 1982; Shumway-Cook & Woollacott, 2019). In dynamic equilibrium, the higher time in the timed up and go is related to the risk of falling (Podsiadlo & Richardson, 1991) as well as an increase in the area and speed of the roll (Deschamps et al., 2014; Nakamoto et al., 2015). There is a consensus that functional decline begins at age 60.

The lack of a multidimensional diagnosis in the morphofunctional aspect prevents the early detection of significant changes in the elderly, especially those related to postural stability and mobility. This fact, in systematic processes, leads to erroneous decision-making in the short and long term because the decline in one functional capacity may or may not be related to others. (Rose, 2014; Alguacil et al., 2017; Torres, 2019).

In Colombia, the lack of studies that relate morphofunctionality and postural control of physically active women whose evaluations are structured in cognitive aspects, level of physical activity, anthropometrics, strength and dynamic and static postural control, and with technology to evaluate older adults outside clinical laboratories, prevents physical activity and health professionals from having a reference according to our population. Faced with the problem described, the following research question arises.

1.2 Research Question

What is the correlation between morphofunctional variables, postural control, and cognitive status in apparently healthy and physically active older adults who attend the healthy habits program?

2. Objectives

2.1 General objective

To relate the morphofunctionality, postural control and cognitive status of older women aged 60-65 and 70-75 at the Centro Vida Años Maravilloso in the city of Bucaramanga through the use of new technologies.

2.2 Specific objectives

✓ To evaluate the morphofunctionality of older adults through anthropometric and physical tests adapted to this population

✓ To know the level of static and dynamic postural control of older adults by means of a triaxial accelerometer incorporated in a smartphone and a Timed up and go test

✓ Discriminate the cognitive status of older adults by applying the Montreal Cognitive Assessment (MoCA)

✓ Establish the level of relationship of the study variables.

3. Methodology

3.1 Epistemological approach

This study was proposed under an empiricist-inductive approach, through which scientific knowledge resulted from the behavior of regularity patterns that would explain the interrelationship between different factual events. The process was carried out through the observation and analysis of the variables, allowing probabilistic inferences about their behaviors. Its relationship with the inductive method is given by the process of access to knowledge, including production and validation through observation and measurement, therefore, this method, supported by sensory instruments and the value of data from experience (hence the empiricist name), allowed to discover patterns of behavior of reality with widely preferable elements such as measurement, statistical analysis, the use of advanced instrumentation, and other similar practices (Padrón, 2000).

The articulation of the principles of the research approach allowed us to respond to the relationship between the variables of morphofunctionality, cognition and postural control of the active women of the "Centro Vida Años Maravilloso" in the city of Bucaramanga.

3.2 Methodological approach

The study adopted a quantitative approach in which the problem of interest was considered as external to the researcher and was approached in an impartial manner, avoiding any type of judgment or personal stance in order to achieve the maximum possible objectivity. The method was structured in a sequential and evidence-based way, where each stage precedes the next and no steps were skipped, although the order was strict, some phases could be redefined. The study arose from an idea and the particular topic was delimited, once determined, the research objectives and questions were formulated; Existing information in the literature was examined and a theoretical framework was developed; The variables were established and then a plan was prepared and the measures were recorded in a specific environment. The results obtained were analyzed through the application of statistical techniques from which conclusions were derived (Hernández-Sampieri & Mendoza, 2018b).

3.3 Scope of research

The study has a correlational scope, because its purpose is to know the relationship or degree of association that exists between two or more variables in a given context through statistical measurement. To a certain extent, it has an explanatory value, albeit limited, because knowledge of the relationship between variables provides some information that contributes to the explanation (Hernández-Sampieri & Mendoza, 2018a)

In this case, the study seeks the relationship between morphofunctionality, cognitive status and postural control of older women aged 60-65 and 70-75 from the "Wonderful Years Life Center" in the city of Bucaramanga through the use of new technologies.

3.4 Materials and methods

3.4.1 Approaches to the experiment

This research was defined as non-experimental, since there was no voluntary manipulation of the variables; In the same way, the subjects were not subjected to intervention or treatments, only focused on observing the phenomena as they occur in the natural environment, with the aim of analyzing them (Hernández-Sampieri et al., 2014).

3.4.2 Population and sample

The population or universe was 85 women aged between 60-65 and 70-75 years, from the Wonderful Years Life Center, beneficiaries of the physical activity programs promoted by the Secretariat of Social Development of the Mayor's Office of Bucaramanga.

The Sample

The sample size was determined by applying the formula according to (Martínez (2012), for the finite population, described below:

$$n = \frac{N * \ Z_a^2 * + p * q}{e^2 * (N - 1) + Z_a^2 * p * q}$$

Where:

n = Sample size of older women to be studied.

N = Population size = 85.

Z = Coefficient (1.96) 95% confidence level parameter.

p = Probability of the event under study occurring: 50%

q = (1-p) = 50% probability of the event under study occurring.

e = Maximum accepted estimation error 5%.

By replacing the values, the result is:

$$n = \frac{85 * \ 1{,}96_{95\%}^2 * + 50 * 50}{0{,}05^2 * (85 - 1) + 1{,}96_{95\%}^2 * 50 * 50}$$

$$n = 70 \ \text{ Muestra total}$$

The calculation of the sample number was defined in 70 participants.

3.4.3 Sampling method

The selection of the sample was determined with the simple random probability sampling method through the Software Decision Analyst Stats 2.0 (Random Numebers Generator). The program randomly generated 70 numbers with minimum values of 1 and maximum of 85, which corresponded to the participant's identification number (Hernández-Sampieri, 2014).

The flowchart explains the sample selection process, group distribution, mean age, and standard deviation

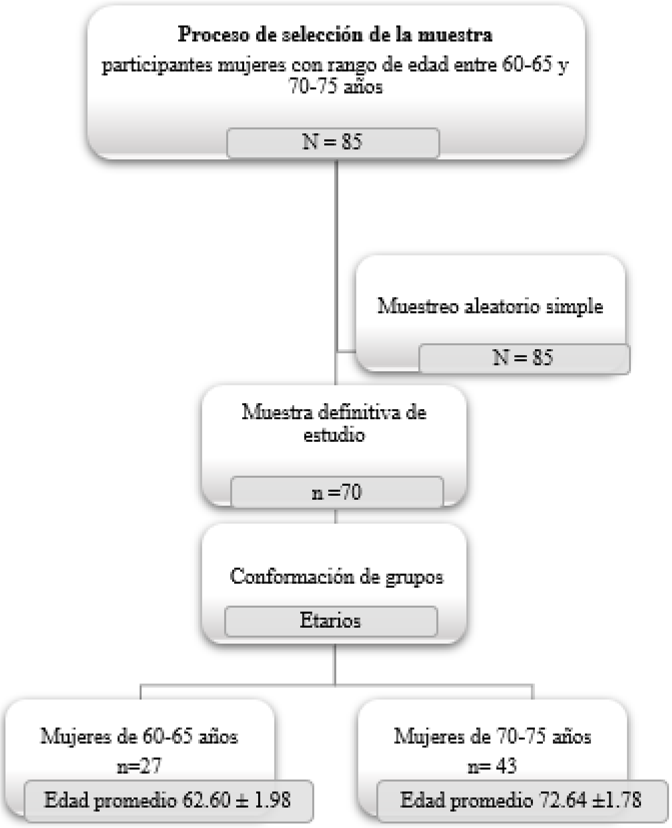

Figure 1. Sample composition and assignment of age groups.

Note: Authors' own elaboration, original version in Spanish

4. Research Results

Below are the results organized by sections with their respective result blocks. In the first section, we find the descriptive analysis and the results of the variables categorized in a general way and by age groups. In the second section, the correlational results.

4.1 Descriptive Results Analysis Section

Descriptive and morphofunctional result blocks

• Population characterization

• Block I. Cognitive Assessments: Mocha

• Block II. Physical Activity Level: Baecke

• Block III. Anthropometric: Height, Body Mass ICC and BMI

• Block IV. Strength: Chair stant test, Dominant and non-dominant hand grip strength

• Block V. Postural control in standing position on BEOA and Tug

4.2 Population characterization

The characterization of the population under study is presented, organized in a general way and by age groups. The information is shown in averages and standard deviations.

Variable	Total, Women's	G60-65	G70-75
Number of people	70	27	43
Average Age	69.8 ± 5.10 years	62.60 ± 1.98 years	72.64 ±1.78 years
Average Body Mass	64.56 ± 0.37 kg	65.97 ± 9.25 kg	63.68± 9.44 kg
Average Height	1.52 ±0.05 m	1.53 ± 0.05 m	1.52 ±0.06 m
Mocha	23.63 ±2.78 pts	23.93 ± 2.59 pts	23.44 ± 2.91pts
Modified Baecke	26.11±3.99 pts	25.75 ±3.68 pts	26.34 ± 4.20 pts

Table 1. Characterization of the population in mean and standard deviation.

Note: Group=G; Montreal Cognitive Assessment: MoCA. Own source ± = Deviation

4.3 Block I. Results of cognitive assessments

In the MoCA, women in general had an average score of 23.63 ± 2.78 pts, the G 60-65, 23.93 ± 2.59 pts and in the G70-75, 23.44 ± 2.91 pts. A higher score was observed in the younger age group, with a 2.05% percentage difference in relation to the older group. In addition, it was observed that women in both age groups have normal cognition.

4.4 Block II results of the assessment of the level of physical activity

As for the modified Baecke, the subjects presented an average score of 26.11 ± 3.99 pts, the G 60-65, 25.75 ± 3.68 pts and the G70-75, 26.34 ± 4.20 pts. A lower score was evidenced in the younger age group with a percentage difference of -2.29% compared to the older group. In addition, the findings indicate an active level of physical activity for both age groups.

4.5 Block III. Results of anthropometric assessments

Height, in the general group of women, presented an indicator 1.52 ± 0.05 m, the G 60-65, 1.53 ± 0.05m and the G70-75, 1.52 ± 0.06m.

Body mass: the total number of women had an indicator of 64.56 ± 9.37 kg, in the G 60-65, 65.97 ± 9.25 kg and in the G70-75 63.68 9.44 kg. The findings indicate higher body mass in the younger age group, with a difference of 3.47% above the older group.

Body mass index, in the general group of women, presented an indicator of 28.00 ± 4.37 kg/m², the G 60-65, 28.30 ± 4.18 kg/m² and the G70-75, 27.82 ± 4.53 kg/m². A higher result was observed in the younger age group, with a margin of 1.70% for the older group. Evidence indicates overweight in women of both age groups, which in turn poses a risk of experiencing cardiovascular disease.

Waist-to-hip index (WCI), the total number of women had an indicator of 0.89 ± 0.07 cm, in the G 60-65, 0.90 ± 0.08 cm and in the G70-75 0.89 ± 0.06 cm. A higher result was noted in the younger age group, with a difference of 1.11% above the older group. The findings indicate that ICC values are above normal ranges, which poses a risk of experiencing co-morbidity in women of both age groups.

4.6 Block IV. Results of Strength Assessments

In the Chair Stand Test, women in general presented an average number of repetitions of 14.46 ± 2.90 reps for G 60-65, 15.15 ± 3.00 and in the G70-75, 14.02± 2.78 reps, it was observed in women in the younger age group, greater number of repetitions, indicating a difference of 7.46% compared to the older group. The findings indicate that lower extremity strength in women in both groups is within average ranges.

In the case of the Dominant Hand Prehensile Force, the subjects recorded an average in kilograms (kg) of 18.22 ± 3.66 kg, the G 60-65, 18.45 ± 4.00 kg and in the G70-75 18.07 ±3.48 kg. Greater strength was observed in the younger age group. Reflecting 2.06% in relation to the Older Group. The findings indicate that the prehensile strength of the dominant hand in both age groups is below the normal average.

Finally, the Prehensile Force, the non-dominant hand of women in general, presented an average in kilograms of 17.13 ± 3.36 kg, the G 60-65, 17.78 ± 3.47 kg and in the G70-75, 16.71 ± 3.26 kg. Greater strength was observed in the younger age group, reflecting the difference of 6.02% in relation to the older group. The findings indicate that the prehensile strength of the non-dominant hand of both age groups is below the normal average.

Variable	General Group		Group 60-65		Group 70-75	
	Stocking	± OF	Stocking	± OF	Stocking	± OF
Age	68,88	5,10	62,60	1,98	72,64	1,78
Height (m)	1,52	0,05	1,53	0,05	1,52	0,06
Mass (kg)	64,56	9,37	65,97	9,25	63,68	9,44
Modified Baecke (Ptos)	26,11	3,99	25,75	3,68	26,34	4,20
MoCA (Ptos)	23,63	2,78	23,93	2,59	23,44	2,91
BMI (kg/m2)	28,00	4,37	28,30	4,18	27,82	4,53
ICC (cm)	0,89	0,07	0,90	0,08	0,89	0,06
Chair Stand Test (Rep.)	14,46	2,90	15,15	3,00	14,02	2,78
Prehensile Strength Dominant Hand (kg)	18,22	3,66	18,45	4,00	18,07	3,48
Prehensile Force Non-Dominant Hand (Kg)	17,13	3,36	17,78	3,47	16,71	3,26

Table 2. Characterization results in mean and SD by age groups

Note: Montreal Cognitive Assessment = MoCA Body Mass Index = BMI, Waist-Hip Index = ICC

4.7 Block V. Results of postural control assessments

The anteroposterior velocity (Vel/AP) in static standing, OA, in the general group, the mean was 80.98 ± 22.57 mm/s; in the G60-65, 86.82 ± 22.46 mm/s and in the G70-75, 77.32 ± 22.11 mm/s. The results show that younger women have a higher VEL. /AP, with a percentage difference of 10.94%, with respect to older women, denoting greater instability in this axis; likewise, in all women, the results of the Vel./PA showed a high risk of falling.

Regarding the mean lateral velocity (Velo./ML), in the general group the mean was 73.68 ±19.11 mm/s; in the G60-65, 78.40 ±17.61 mm/s and in the G70-75, 70.71 ± 19.62 mm/s. The findings show that younger women have a higher VL/PA, with a percentage difference of 9.81%, compared to older women, registering greater instability in this direction, likewise, in all women, the VEL/PA results indicate a high risk of falling. High rocking speeds in adults imply an increase in postural instability in static standing. Thus, the rocking of the body becomes faster since the response time to control is slower in older people, as a result of the decrease in strength, activation time in synergistic muscles and decrease in sensory sensitivity of the mechanoreceptors in the sole of the foot.

Variable	Group	Stocking	± OF
Vel/AP (mm/s)	General	80,98	22,57
	60-65	86,82	22.46 to
	70-75	77,32	22,11
Vel/ML (mm/s)	General	73,68	19,11
	60-65	78,40	17,61
	70-75	70,71	19,62

Table 3. Result of postural control variables in static standing with eyes open

Note: Antero-posterior velocity: Vel/AP, Medio-lateral velocity: Vel/ML

At last. In the Timed up and go, the general group presented a time of 8.18 ± 1.20 s, in the G60-65, 7.9 ±11.22 s and in the G70-75, 8.35 ±1.17 s. A shorter time was evidenced in the older group, with a percentage difference of 5.56% compared to the younger age group. The findings reflect a functional capacity in normal dynamic balance in women of both age groups.

Variable	Group	Stocking	OF
T/ TUG(s)	General	8,18	1,20
	60-65	7.91	1,22
	70-75	8.35	1,17

Table 4. Timed up and go time results

Note: Timed up and go time (T/TUG), Seconds: S

4.8 Correlational analysis

The results between the cognitive, morphological, and neuromuscular variables are presented below with the postural control variables of physically active women. Using bivariate Pearson correlation, r = statistical relationship coefficient, sig = bilateral significance n = sample number.

			Postural control		
			Static		Dynamic
Block	Variables		Vel/AP	Vel/ML	TUG
I	MocA(pts)	r for Pearson	-0,239*	-0,175	-0,222
		Sig.(bilateral)	0,046	0,147	0,065
		N	70	70	70
II	Baecke (pts)	r for Pearson	-0,178	-0,17	-0,026
		Sig.(bilateral)	0,141	0,159	0,832
		N	70	70	70
III	Mass (kg)	r for Pearson	-0,074	-0,134	0,08
		Sig.(bilateral)	0,544	0,268	0,509
		N	70	70	70
	Height(m)	r for Pearson	0,229	0,236*	-0,158
		Sig.(bilateral)	0,057	0,049	0,193

		N	70	70	70
IV	CST (Rep)	r for Pearson	-0,019	-0,021	-0,364**
		Sig.(bilateral)	0,874	0,866	0,002
		N	70	70	70
	FPMMD (Kg)	r for Pearson	-0,072	-0,108	-0,093
		Sig.(bilateral)	0,552	0,372	0,445
		N	70	70	70
	FPMMND(Kg)	r for Pearson	-0,048	-0,103	-0,167
		Sig.(bilateral)	0,694	0,394	0,166
		N	70	70	70

Table 5. Correlations of morpho-functional variables with postural control variables (anteroposterior and midlateral velocity)

Note.** Correlation is significant at level 0.01 (two-sided)* Correlation is significant at level 0.05 (two-sided), Pearson's r = Correlation coefficient, Sig. = statistical significance, MocA = Montreal Cognitive Assessment, CST = Chair stand test, FPMMD = Manual grip strength, dominant hand, FPMMND= Manual grip force, non-dominant hand, Vel = Speed, AP = posterior antero, ML = Lateral middle; Tug=Timed upa and.

4.9 Results Block I. Cognitive

The result obtained from the correlation between MocA and Vel/AP was low with a Pearson r value of -0.239 and a sig. value (bilateral) = 0.046. The negative correlation coefficient indicates that when the cognitive function score increases, the speed of displacement in the anteroposterior swing decreases proportionally. It should be noted that a lower swing speed results in greater stability of the body, Therefore, a better performance in cognitive function affects a more efficient stability in static standing

4.10 Results Block III. Anthropometric

The results of the correlation test between Height and Vel/ML were low, with Pearson's r-value of 0.236 and a sig. value (bilateral) = 0.049). The positive correlation coefficient indicates that increasing the height of the center of mass produces an increase directly proportional to the speed in the swing of the mid-lateral axis, which generates postural imbalance.

4.11 Results Blocks IV. Strength

The correlation between CST and TUG was low, with Pearson's r-value of -0.364 and a sig. value (bilateral) = 0.002). The positive correlation coefficient indicates that increasing leg strength proportionally decreases the TUG time in seconds, i.e., better leg strength performance is related to better dynamic postural control.

5. Discussion

The aim of the study was to relate morphofunctionality, postural control and cognition of older adults.

In the results of the study, it was found that women in general presented a MoCA score of 23.63 ± 2.78 pts; the G60-65, 23.93 ± 2.59 pts and the G70-75 23.44 ± 2.91 pts, in addition, a higher score could be observed in older women. The findings indicate normal cognition for women in both groups and a slight decline in cognitive function in older women. Our results are consistent with Pedraza et al. (2016), who show that higher MoCA scores are related to improved cognitive function and decline in cognitive function with advancing age. Within this context, Navaratnarajah & Jackson (2017) argue that, with aging, the density of the brain decreases by about 30% in much of gray matter, even the main neurotransmitters decrease, producing adverse effects on cognitive and motor function. Along the same lines, Erickson et al. (2022) reaffirm the relationship between changes in the brain and advancing age and decline in cognitive function.

Daily physical activity in the modified Baecke questionnaire, subjects presented an average score of 26.11 ± 3.99 pts, the G 60-65, 25.75 ± 3.68 pts and the G70-75, 26.34 ± 4.20 pts. the scores in general indicate that women are physically active according to the reference values of Vilaró et al. (2007). However, it was observed that women in the 70-75 group had higher scores, which subjectively means that they performed more physical activity during the last 12 months. These results are consistent with López & Izquierdo, (2015) who state that although there are physiological changes over the years, it is common for active people to have greater performance at all ages.

In terms of body mass index, the general group of women presented an indicator of 28.00 ± 4.37 kg/m², the G 60-65, 28.30 ± 4.18 kg/m² and the G70-75, 27.82 ± 4.53 kg/m². The results show that women of both age groups are overweight, a cardiovascular risk factor according to the WHO classification (2011), and the arguments of Xing et al. (2023) state that the accumulation of body fat is related to the risk of cardiovascular disease in older adults.

In the waist-to-hip index (WHR), women in general had a value of 0.89 ± 0.07 cm; in the G 60-65, 0.90 ± 0.08 cm and in the G70-75 0.89 ± 0.06 cm. The results indicate a risk of comorbidities associated with metabolism, our results agree with Huxley et al. (2010) who corroborate in their review study that high CHFs are related to the risk of metabolic diseases, along the same lines Mitchell et al. (2012) argue that muscle tissue is infiltrated by adipose tissue with advancing age. The findings of (Amorim et al., 2022) indicate that older adults with better physical performance had lower rates of overweight and obesity.

In the Chair Stand Test, women overall performed an average number of repetitions of 14.46 ± 2.90 reps; in the G 60-65, 15.15 ± 3.00 and in the G70-75, 14.02 ± 2.78 rep, the results show that women's leg strength in general is within normal averages and a minimal decline in women in the G 70-75, our findings are consistent with (Rikli & Jones, 2013a) reporting the decline in leg strength functionality over the years. Our results differ from those of Goda et al. (2020), because their findings indicate averages above 20 repetitions on the Chair stand test in 30 seconds in older women. The explanation for the poor performance in the functionality of strength in our women is possibly due to the low content of this ability in their daily activities.

In the case of the Hand Dominant Prehensile Force, women generally recorded an average in kilograms (kg) of 18.22 ± 3.66 kg; the G 60-65, 18.45 ± 4.00 kg and the G70-75, 18.07 ± 3.48 kg and in the Prehensile Force, a non-dominant hand for women in general, it was 17.13 ± 3.36 kg; the G 60-65, 17.78 ± 3.47 kg and the G70-75, 16.71 ± 3.26 kg. The results showed that the strength in the dominant and non-dominant hands are below normal averages, likewise, less strength was found in the G 70-75, so that the prehensile strength is lower in older women. The results are consistent with Wang et al. (2018). Since in their study they show that manual prehensile strength decreases with advancing age. The claim is supported by studies (Kamel et al., 2002; Clark & Manini. 2012; Collins et al., 2019) who argue that strength declines with advancing age.

In postural control, in static standing, with eyes open, the results of anteroposterior velocity (Vel./AP) of the women in the general group presented a mean of 80.98 ± 22.57 mm/s; in the G60-65, 86.82 ± 22.46 mm/s and in the G70-75, 77.32 ± 22.11 mm/s, evidencing in younger women, higher Vel /AP and therefore better stability in this axis.

Regarding the mean lateral velocity (Vel./ML), in the general group, the mean was 73.68 ±19.11 mm/s; in the G60-65, 78.40 ±17.61 mm/s and in the G70-75, 70.71 ± 19.62 mm/s, finding that younger women registered higher Velocity/PA compared to older women. However, in all women, the findings with both variables indicated a high risk of falling, the assessment was based on Norris et al. (2005), who found in older people with high risk of falling a mean swing speed of 47.79. In the same vein, Hayashi et al. (2012) report that older adults who are physically active and have a more preserved exercise capacity have more postural stability, and (Roman-Liu, 2018) in their meta-analysis of results confirm that AP and ML rocking speed increase with age.

In the Timed up and go, the general group presented a time of 8.18 ± 1.20 s; in the G60-65, 7.9 ±11.22 s and in the G70-75, 8.35 ±1.17 s. A shorter time was evidenced in the older group, with a percentage difference of 5.56% compared to the younger age group. The findings reflect a functional capacity in normal dynamic balance in women of both age groups. Our results coincide with Pereiro et al. (2021) who found that the time in the Timed up and go test increases with age, even in women with their functional abilities preserved, in the same line, Oliveira-Zmuda et al. (2022) also state that high times are related to the risk of falls.

In the results of the study, it was possible to determine that, between global cognitive function and rocking speed in the anteroposterior axis, there is a low bilateral correlation with a negative coefficient, which indicates that a better performance of cognitive function is associated with a lower rocking speed, reflected in greater stability in static standing. In the same vein, (Hayashi et al., 2012; Roman-Liu, 2018) indicate that lower speed and high performance in physical activity are associated with greater stability. Thus, our results coincide with the study by (Xiao et al.2020), who found in older adults that global cognitive function and static balance are positively correlated, evidencing that a higher score on the Moca is associated with better stability in older adults, in this sense, Alonso et al. (2016), They explain that daily activities not only require balance, but also normal cognitive function to maintain postural control; This taking into account Deschamps et al. (2014) in the study report that higher rates in the speed of swinging in static standing are related to those people who presented cognitive impairment.

The results between height and mean lateral swing velocity reflected a low and positive relationship, which specifies that the higher the center of mass in the body, the greater the swing velocity in the anteroposterior axis in static standing, which causes body instability. The result agrees with that of Castilho et al. (2012), who found a positive relationship between height and swing speed and in static standing with eyes open. The explanation for this result is argued by Tejada et al. (2016) who indicate that a higher height of the center of mass produces greater speed in body swing, so that it generates more instability in standing, which makes it difficult to regain postural control in the face of threats of disturbance.

As for the correlation obtained between the CST and TUG was -0.364 and a p value < (= 0.01) which implies that there is a low and negative correlation, the greater the leg strength the time spent in the TUG decreases, which means better dynamic balance in older women, this result agrees with Wiśniowska-Szurlej et al., (2019), who found in their study a negative correlation between leg strength and dynamic balance and indicates that early diagnosis is crucial to cope with the decline in physical abilities during aging. Following this line, the results of Benítez (2020) coincide with ours, since he found an inverse correlation between leg strength and TUG and points out that strength is a determining factor in maintaining physical abilities, especially mobility in older adults. Likewise, the results of the study by Tommerdahl et al., (2022), who found in older adults a negative correlation between the variables of the Chair stand test and dynamic equilibrium and highlights the role played by strength as a determining factor on the capacity of dynamic balance.

6. Conclusions

In this study, the morphofunctionality, postural control and cognitive status of women with an age range between 60-65 and 70-75 were related to the Wonderful Years Life Center in the city of Bucaramanga, and postural control measurements were carried out with a triaxial accelerometer incorporated into a smartphone that allowed evaluation outside the clinical laboratories in a practical way and with advanced technology available to everyone because of its low cost.

The morphofunctionality of women in general was evaluated with anthropometric methods and adapted physical tests, in such a way that overweight and waist and hip indicators were found to represent high cardiovascular risk and diseases associated with metabolism. In terms of functionality, they are physically active, with normal strength in the lower extremities and low manual grip strength, both in the dominant and non-dominant hand.

The level of static postural control of the women was known through the measurements provided by a triaxial accelerometer incorporated in a smartphone that detected high velocities in swaying of the anteroposterior and midlateral axis, which affect postural control in static standing, producing an increase in instability and the risk of falls. However, the speed was lower in older women, reflecting better postural stability on both axes. In the dynamic postural control, both groups of women presented a level of normality.

The cognitive status of older adults was discriminated with the application of the Montreal Cognitive Assessment (MoCA), in such a way that it was determined that women are cognitively normal, however, they are only one point away from their condition changing to mild cognitive impairment.

The level of relationship of the study variables was established, so that there was only a bilateral correlation between cognition and negative or inverse static postural control (Vel./AP), which showed that, with the increase in performance in cognitive function, the speed of rolling decreases, which represents better stability. On the other hand, Height and Static Postural Control (Vel./ML) were positively related because the higher the center of mass, the greater the speed of the oscillation in the mid-lateral axis, generating greater instability of the body in the mid-lateral axis. On the other hand, the function of leg strength and dynamic postural control were negatively or inversely related because when leg strength increases, the time spent on body mobility in the TUG decreases.

The morphofunctional influence on static and dynamic postural control depends on the maintenance with which the functional capacities and adequate proportions of the body have been preserved, to face the challenges offered by the environment when carrying out the basic activities of daily living. On the contrary, inadequate maintenance could increase the risk of falling, affecting dependency and therefore the quality of life of older adults.

The study provides reference information to physical activity and health professionals crucial in the detection of the most significant functional losses of aging, so that they can provide an early and timely multidimensional diagnosis of the particular or collective conditions of older adults, allowing the development of exercise programs and plans adjusted to particular or collective conditions that lead to morphic improvement functional and postural control. Likewise, the study has the potential to contribute to future research that seeks to deepen the subject.

Recommendations: It is recommended to implement exercise programs focused on improving strength and static and dynamic postural control that involve cognitive tasks so that women can maintain functionality and healthy active aging.

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