RELATIONSHIP BETWEEN FUNCTIONAL MOBILITY AND HEARING AND VISUAL ACUITY IN THE ELDERLY

RELAÇÃO ENTRE A MOBILIDADE FUNCIONAL E A ACUIDADE AUDITIVA E VISUAL EM PESSOAS IDOSAS

RELACIÓN ENTRE LA MOVILIDAD FUNCIONAL Y LA AGUDEZA AUDICIÓN Y VISUAL DE LAS PERSONAS MAYORES

Vítor Pinheira – Dr. Lopes Dias School Health, Polytechnic Institute of Castelo Branco; Interdisciplinary Research Unit – Aged Functional Communities (Age.Comm), Castelo Branco, Portugal.
ORCID: https://orcid.org/0000-0003-2580-7508

Pedro Seabra – Dr. Lopes Dias School Health, Polytechnic Institute of Castelo Branco; ASFE Saúde, Castelo Branco, Portugal.
ORCID: https://orcid.org/0000-0003-2825-0039

Ana Catarina Moura – Dr. Lopes Dias School Health, Polytechnic Institute of Castelo Branco; APPACDM de Castelo Branco, Castelo Branco, Portugal.
ORCID: https://orcid.org/0000-0001-9314-6954

Corresponding Author/Autor Correspondente:
Vítor Pinheira – Instituto Politécnico Castelo Branco, Portugal. vpinheira@ipcb.pt

ABSTRACT

Introduction: Functional mobility is associated with the ability to perform activities of daily living, essential for maintaining the autonomy of the elderly. Decreased hearing acuity leads to decreased participation in the community, the ability to detect the origin of sounds and become more exposed to the environment. Changes in vision have been associated with physical disability and functional disabilit. Vision accounts to the information from the outside world, essential for interactions with others and the environment.

Methods: A cross-sectional, non-experimental correlational study was conducted with individuals aged 55-96 years. Hearing acuity was assessed using the Hearing Test-Pure Tone application, visual acuity through the Snellen Scale and functional mobility was assessed using the Timed Up and Go. The data collected were processed using the SPSS program.

Results: The correlation between TUG values and the ear with better hearing acuity was obtained a moderate positive correlation (r=0.394), statistically significant. There is also a moderate negative correlation (r=-0.412) between the TUG values and better visual acuity, statistically significant.

Conclusion: The present study concluded that people with impaired hearing or visual acuity present a decrease in their functional mobility.

Keywords: Aging; Hearing; Physical Functional Performance; Vision Ocular.

RESUMO

Introdução: A mobilidade funcional está associada à capacidade de realização das atividades da vida diária, essencial na manutenção da autonomia das pessoas idosas. A diminuição da acuidade auditiva leva a uma diminuição da participação na comunidade, da capacidade de detetar a origem dos sons, ficando mais exposto ao meio ambiente. Também as alterações na visão têm sido associadas à incapacidade física e causa de incapacidade funcional. A visão é responsável por muitas informações do mundo exterior, essenciais nas interações com os outros e com o ambiente.

Métodos: Estudo correlacional, transversal e não experimental com amostra dos 55 aos 96 anos. Acuidade auditiva avaliada pela aplicação *Hearing Test-Pure Tone*, acuidade visual pela Escala de Snellen e mobilidade funcional pelo *Timed Up and Go*. Os dados foram tratados pelo programa SPSS.

Resultados: Na correlação entre o TUG e o ouvido com melhor acuidade auditiva existe correlação positiva moderada (r=0,394), estatisticamente significativa. Existe correlação negativa moderada (r=-0,412), entre os valores do TUG e do olho com melhor acuidade visual, estatisticamente significativa.

Conclusão: O presente estudo conclui que as pessoas com comprometimento da acuidade auditiva ou visual apresentam uma diminuição na sua mobilidade funcional.

Palavras-chave: Audição; Desempenho Físico Funcional; Envelhecimento; Visão Ocular.

RESUMEN

Introducción: La movilidad funcional se asocia con la capacidad de realizar actividades de la vida diaria, esenciales para mantener la autonomía de las personas mayores. La disminución de la agudeza auditiva conduce a una disminución de la participación en la comunidad, en la capacidad de detectar el origen de los sonidos, quedando más expuesto al medio ambiente. Los cambios en la visión también se han asociado con discapacidad física y una causa de discapacidad funcional. La Vision es responsable de una gran cantidad de información del mundo exterior, esencial en las interacciones con los demás y el medio ambiente.

Métodos: Estudio correlacional, transversal y no experimental con una muestra de 55 a 96 años. Agudeza auditiva evaluada por la aplicación *Hearing Test-Pure Tone*, agudeza visual por la escala de Snellen y movilidad funcional por *Timed Up and Go*. Los datos fueron procesados por el programa SPSS.

Resultados: En la correlación entre TUG y el oído con mejor agudeza auditiva, existe una correlación positiva moderada (r=0,394), que es estadísticamente significativa. Existe una correlación negativa moderada (r=-0,412) entre los valores del TUG y el ojo con la mejor agudeza visual, que es estadísticamente significativa.

Conclusión: El presente estudio concluye que las personas con deterioro de la agudeza auditiva o visual tienen una disminución en su movilidad funcional.

Descriptores: Audición; Envejecimiento; Rendimiento Físico Funcional; Visión Ocular.

INTRODUCTION

The World Health Organization (WHO) defines the elderly population in developed countries as being an individual who is 65 years-old or older and in developing countries who is 60 years-old or older[1]. The number of people over 60 is growing faster than any other age group, worldwide[2,3]. According to the National Statistics Institute (INE) in 2017, the aging rate in Portugal was 155.4 elderly people for every 100 young people[4].

The aging of the population in Europe has increased, which means that there is also an increase in people with visual problems[5]. Visual impairment is generally defined by the value of visual acuity, which is part of an individual's functional vision. It is the best value to characterize visual loss, and is considered the criterion for the definition of visual impairment by WHO[6].

Over time, the aging process leads to a gradual loss of physiological reserves, an increased risk of contracting various diseases and a general deficit in the individual's intrinsic capacity[7].

Among sensory losses, changes in vision have been associated with physical disability and correspond to the third cause of functional disability in the elderly, after problems related to the locomotor system and those of cardiovascular origin[8]. Vision is maybe the most important sense; approximately 80% of information from the outside world is incorporated through visual pathways[9].

The mobility concept is defined as: "Acting or the ability to move from the present position to the desired position in another part of the environment in a safe, graceful, efficient and comfortable way". The loss of mobility can make the performance of activities slow, demanding and exhausting[5,10].

The decline in the visual function of the elderly people is a source of concern in public health. Despite its high prevalence, the majority do not mention complaints about vision because they consider this deficit to be typical of age[6].

Hearing loss is the third most common chronic condition in the elderly people, and over 90 years-old, approximately 90% have it[11,12], it is estimated that individuals over 80 years-old do not understand about 25% of the words spoken in a conversation, having to guess or deduce its meaning[13]. Hearing loss associated with aging is called presbycusis, characterized by a gradual increase after 55 years-old, especially in high sound frequencies[14]. The human being has sensitivity to detect sounds between 20 Hz to 20 thousand Hz[15].

The WHO estimates that there are 360 million people with hearing problems, which corresponds to 5.3% of the world population[16]. According to the 2011 census, there are 506,342 Portuguese people with difficulty in hearing, which corresponds to 4.47% of the population. Of these, 18.26% are in the age group over 65 and 33.61% are in the age group over 80[17].

WHO considers that there are four levels for the hearing classification. Level zero listening below 25dB, level 1 listening between 26 and 40dB, level 2 listening between 41 and 60dB, level 3 listening between 61 and 80dB and finally, level 4 listening only to sounds above 81dB. Since level zero means no hearing loss (normal hearing), level 1 means slight loss, level 2 means moderate loss, level 3 means severe loss and level 4 means profound loss or even deafness[18].

The decrease in auditory acuity leads to a decrease in participation in the community due to the fact that with hearing loss, the human being loses the ability to detect the origin of sounds, thus becoming more fragile and exposed to the environment[15,19].

The present study aims to assess the relationship between deficits in visual and/or auditory acuity and functional mobility in elderly people, and it is expected that elderly people with impairment in one or both of the acuities under study will have their functional mobility reduced.

MATERIAL AND METHODS

This study was carried out in the districts of Aveiro, Viseu and Castelo Branco. Data collection started in late July 2018 and ended in March 2019.

This study is classified as being probabilistic for convenience, non-experimental, transversal and correlational, having a positive opinion on the part of the Ethics Committee of the Escola Superior de Saúde Dr. Lopes Dias (Opinion 93/CE-ESALD/2018).

The study sample consists of 87 subjects aged over 55 years-old of both sexes.

Inclusion criteria were defined for this study, namely: Individuals aged 55 years-old or older, who maintain their cognition preserved and who are able to sign informed consent. Exclusion criteria were defined as: being blind, having hearing loss level 4, having otitis, having otosclerosis, having vestibular disorder, diagnosed progressive neurological disease, dementia, degenerative diseases, operations or surgery on the lower limbs for less than 6 months and limitations physical and sensory disabling activities of daily living.

From the initial sample (n=105), 18 people were excluded, 1 for having the TUG result well above the reference values for age and 17 for having scores on the Mini Mental State Examination indicating moderate cognitive deficits.

Before starting the tests, a brief explanation was given to the participants of what was going to be carried out and the tests that were going to be applied and subsequently a free and informed consent was signed by all the participants.

Then, a characterization questionnaire was carried out to the participants, where their sociodemographic data, height and weight were collected so that they could be registered, guaranteeing their confidentiality and anonymity, and the data were only used as a means of evaluation and statistics.

The Time Up and Go (TUG) test was performed in order to assess the participants' functional mobility. The TUG was performed three times by each participant and the shortest time was selected.

The mean time (95% confidence interval) of the TUG for individuals at least 60 years-old is 9.4 seconds (8.9-9.9). The mean (95% confidence interval) for 3 age groups is: 8.1 (7.1-9.0) seconds for 60 to 69 years-old, 9.2 (8.2-10.2) seconds for 70 to 79 years-old and 11.3 (10.0-12.7) seconds for 80 to 99 years-old[20].

The Snellen scale was applied to assess the visual acuity of the participants. Visual acuity is the main clinical tool for functional vision assessment. In this sense, the use of visual acuity tables is, without a doubt, the most common practice of ophthalmological examination[21].

This assessment is widely used because it can be understood by literate and illiterate people; it is easy to use and low cost. It was performed first with the right eye and then with the left eye where the participant must indicate whether the letter "E" is facing up, down, right or left[21]. If the participant wore glasses to see from a distance, they were kept during the test[22].

The score was recorded according to the last line that the participants read the "E's" correctly. The value of visual acuity is described by the decimal value displayed next to each line of the graph, in which values less than 0.7 are indicative of impaired visual acuity, as adopted by some authors[6,22].

In the data analysis, only the visual acuity value of the eye that has the best score on the Snellen scale was considered.

Hearing acuity was assessed using the Hearing Test – Pure Tone smartphone application, using headphones.

The application during the test emits a sound at different sound frequencies, varying the level of dB at which it is emitted, in each frequency. There are three possible answers: "I can't hear", "almost inaudible" and "I can hear". Depending on the response, the application increases or decreases the dB level, and when the response is "almost inaudible" the test changes frequency. In the end, the application gives the results in dB and according to the results, the hearing levels proposed by the WHO are obtained, and in general the lower the dB level, the better the hearing acuity[23-26].

In addition to this objective assessment, a subjective assessment was also carried out through the question "Do you have a hearing problem?", if so, a second question was asked "Do you use any type of corrective device?"

The analysis and processing of statistical data was performed using the Statistical Package for the Social Sciences, version 21.0 for Windows (SPSS) software.

Descriptive statistics were used to describe the variables with measures of central tendency (mean and mode) and dispersion (standard deviation).

Spearman's correlation test ($p<0.01$) was used to correlate the variables of vision and Functional Mobility (TUG) and Age and Vision ($p<0.01$) for non-parametric variables.

Spearman's correlation ($p<0.01$) was used to correlate hearing variables and Functional Mobility (TUG). Pearson's correlation ($p<0.01$) was used to study the relationship between the auditory variables.

RESULTS

The sample is composed of 87 individuals, from which 33.3% are male and 66.7% are female, with an average age of 76.39 years-old. Of this sample, 46% had institutional support (day care or residential structure for the elderly) and the remaining 54% are inserted in the community.

Data analysis is based on collections that the subjects use their visual correction instruments, and it can be concluded that only 8% do not have visual deficits, 4.6% have visual deficits and 87.4% have visual deficits but corrected.

Table 1 – Description of visual variables.

	N	Minimum	Maximum	Average	Standard deviation
TUG (Seconds)	87	5.72	33.92	11.52	5.28
Eye with Better Visual Acuity	87	0.1	1	0.60	0.22
Difference Right/Left Eye	87	0	0.9	0.13	018
Right Eye	87	0	1	0.53	0.25
Left Eye	87	0	1	0.54	0.24

In the visual acuity assessment (Table 1), it was found that the average of the eye with the best acuity is 0.60±0.22, the difference between the right eye and the left eye is 0.13±0.18, the right eye 0.53±0.25 and the left eye 0.54±0.24 with the best result in both eyes 1 and the worst 0.

In the assessment of functional mobility through the TUG (Table 1), it is obtained that the average value is 11.52±5.28 in which the best value is 5.72 seconds and the worst is 33.92 seconds.

Spearman's correlation test was performed between age and eye variables with better visual acuity and it was found that there is a statistically significant moderate negative correlation (r=-0.495).

Table 2 – Correlation between Best Eye and TUG.

			Best Eye	Right Eye	Left Eye
Spearman's Ro	TUG	Correlation Coefficient	-.412**	-.361**	-.350**

The Spearman correlation test was performed between the time variable obtained in the TUG and the eye with the best visual acuity (Table 2) and it was proved that there is a statistically significant moderate negative correlation (r=-0.412).

Regarding the hearing of the sample, 77% of the individuals reported that they did not have any hearing loss, 19.5% reported uncorrected hearing loss and only 3.4% reported corrected hearing loss, when asked with the question "Do you have any hearing problems?", if so, they were asked with "Do you use any type of corrective device?".

Table 3 – Description of the hearing variables.

	N	Minimum	Maximum	Average	Standard deviation
TUG (seconds)	87	5.72	33.92	11.52	5.28
Average Hearing (decibels)	87	16	76	41.48	11.75
Best Ear (decibels)	87	8	75	39.14	12.18
Right Ear (decibels)	87	8	75	41.44	12.23
Left Ear (decibels)	87	14	78	41.57	12.44
Difference Right/Left Ear (decibels)	87	0	42	4.51	6.36

In the hearing evaluation, assessed by the Hearing Test – Pure Tone application, it was found that 12.6% have normal hearing, 49.4% slight loss, 32.2% moderate loss and 5.7% have severe loss, that is, 12.6% of the sample had hearing considered normal and 87.4% had hearing loss. An average hearing for both ears of 41.48 dB (95% CI 38.98-43-99) was also obtained (Table 3).

For the right ear, the best result is 8dB and the worst result is 75 dB (95% CI 38.83-44.04), while the left ear has the best result 14dB and the worst result 78dB (95 CI% 38.92-44.23), and on average the difference between the right ear and the left ear is 4.51dB (95% CI 3.15-5.86) (Table 3).

For the best ear we have as results 8dB of lowest value and 75dB (95% CI 36.54-41.74) as the highest value (Table 3).

In the data collected through the TUG, we have an average value of 11.75 seconds (95% CI 10.40-12.65), according to the same data, 56.3% of the sample is classified as having a risk of decrease and, therefore, in turn, 44.7% is classified as having no risk of decrease, according to the normative values in relation to age (Table 3).

Table 4 – Cross tabulation between the Risk of decrease and the Hearing Level.

	Hearing level								
	Normal hearing	%	Slight Loss	%	Moderate Loss	%	Severe Loss	%	Total
Risk of decrease									
No	5	13.2	19	50.0	14	36.8	0	0	38
Yes	6	12.2	24	49.0	14	28.6	5	10.2	49
Total	11	12.6	43	49.4	28	32.2	5	5.7	87

Crossing the data on the risk of decrease with the data on the hearing level (Table 4), we obtain that of the individuals without risk of decrease, 5 have normal hearing, 19 slight loss, 14 moderate loss and none has severe loss, on the other hand, in individuals at risk of falling, we obtained that 6 have normal hearing, 24 slight loss, 14 moderate loss and 5 severe loss.

Regarding the correlations between the auditory variables (Average Hearing, Best Ear, Right Ear, Left Ear and Difference Right Ear Left Ear), applying Pearson's Correlation, high correlations were obtained and with statistical significance ($p<0.01$).

Tabela 5 – Correlation between TUG and Auditory Acuity.

				Average hearing	Best ear	Right ear	Left ear
Spearman's ro	TUG	Correlation Coefficient		.470**	.394**	.428**	.454**

The correlation between TUG values and hearing variables (Table 5), applying Spearman's Correlation, revealed a moderate correlation, with r=0.394 (Best Ear), with statistical significance ($p<0.01$).

DISCUSSION

The visual system is responsible for providing information about the environment, allowing the spatial imagination of where we are, as well as body orientation and perception. After 50 years-old there is a progressive decrease[27,28]. Visual impairment is defined by the value of visual acuity, which according to WHO is considered a criterion for the definition of visual impairment. Deficits in visual acuity are one of the factors that are most associated with the difficulty in performing basic daily activities in the elderly people[6].

With age, the visual system takes on a major role in regulating postural control, to the detriment of other receptors there is a progressive loss of this system that influences the mobility of individuals[6,29]. Elderly people with more advanced ages, between 75 years-old and up to more than 90 years-old, the prevalence of low vision increases dramatically from 5.6% to 30.0%[30]. Thus, it is to be expected that the older the subjects, the greater the impairment in their visual acuity, which is demonstrated by the moderate negative correlation of these variables (r=-0.495). The results are in line with expectations, and it can be concluded that with increasing age there is an inversely proportional relationship with visual acuity. It is also important to mention that among the variables correlated with the values of visual acuity (Snellen table), the age was the one with the highest level of correlation with visual deficit.

Ribeiro *et al*[31] states that the progressive and gradual decrease in vision forces the elderly people to adapt to the way they perform their activities of daily living and that visual impairment is also directly related to the restriction/limitation of them in society, because deficits in visual acuity contribute to the functional decline of the elderly population.

Normal aging is associated with a decrease in the visual field. It has been shown in studies that the loss of the visual field proved to be a significant predictor of mobility performance, showing that the decrease in visual acuity is not only related to the visual system, but also to the mobility in general of the elders[32].

In the present study, TUG was used in order to assess the subjects' functional mobility. Bohannon[20] determines the time reference values in the TUG for the elderly people according to the age groups.

Visual acuity shows a relationship with mobility, because while walking, vision is one of the most recruited systems to analyze the spatial location and body movement, as well as environmental conditions. Subjects with visual deficits are more prone to mobility pro-

blems, have problems and difficulties in carrying out their activities of daily living (ADL), since vision is the sense that captures external stimuli[5,8]. The loss of mobility can make the performance of activities slow, demanding and exhausting, and it is associated with a greater risk of decrease, loss of independence and sometimes leads to the institutionalization of individuals[10].

West *et al*[33] demonstrated that there are significant associations between mobility limitations and visual acuity. Subjects with decreased visual acuity have a deficit in their functional mobility, which is demonstrated by the existing moderate negative correlation of these variables (r=-0.412). It can be concluded that with the decrease in the visual acuity values there is an increase in the execution time of the TUG.

Regarding the relationship between functional mobility and hearing acuity in elderly people, it is concluded that there is a moderate, but statistically significant, relationship between the two variables. This relationship is in line with other studies that concluded that the decrease in functional mobility is related to a decrease in hearing acuity[34-36].

The percentage of people with self-reported hearing loss was different in the various studies, in this study it was found that 77% of the individuals think they have hearing without loss, whereas in the study by Polku *et al*[34] only 33% reported they do not have hearing loss, 13.4% have hearing correction compared to 3.4% in this study. The results of the present study are in line with those of Tomioka *et al*[37] in which 72% reported they do not have hearing loss. This difference can be explained by what each individual considers being a hearing without hearing loss, since with the advancing age it is normal to decrease hearing acuity, in this way individuals can think that their hearing losses are normal and thus have a perception of their altered hearing[14]. The difference between the results of this study and those of Polku *et al*[34] can also be explained by the fact that the sample under study by them is in a more restricted and higher age range, between 75 and 90 years-old.

Regarding the dB perceived by individuals, the results are slightly in line with the studies by Koh *et al*[38] and Chen *et al*[36] Koh *et al*[38] obtained an average hearing of 36.1dB for the right ear, 35.6dB for the left ear and 33.6dB for the best ear, and Chen *et al*[36] found an average hearing of 33.7dB. The difference of approximately 10dB between the results of this study and those ones from Koh *et al*[38] and Chen *et al*[36] can be explained by the fact that the Hearing Test – Pure Tone application in comparison with a professional audiometry presents a difference of 2.6dB (95% CI 2.0-3.1), with a standard deviation of 8.3dB (95% CI 7.9-8.7)[25].

Regarding functional mobility, Haas *et al*[11] obtained a mean TUG value of 8.1 seconds, as opposed to the 11.52 seconds obtained in this study. This difference can be explained by the fact that in the study by Haas *et al*[11] the population under study has an age range between 21 and 94 years-old and by being individuals only from the community, theoretically with better physical performance[11]. Koh *et al*[38] obtained a result similar to that of Haas *et al*[11] of 8.9 seconds in the TUG; however this difference can be explained by the fact that in the sample there are no institutionalized individuals, being theoretically a sample with less limitations.

Returning to the focal point of this study, the relationship between functional mobility and hearing acuity, a moderate correlation of 0.394 (p<0.01) was obtained between functional mobility and the best ear, and this result can be explained by one of the limitations of this study, that is, the fact that the sample mainly comprises institutionalized individuals. On the other hand, the fact that the assessment of auditory acuity was carried out in an objective way is a strong point of this result.

This research provides more information about the relation between functional mobility and hearing and visual acuity in the elderly people. Given the increase in the number of elderly people worldwide, an early assessment and recognition of hearing and visual difficulties is necessary to reduce the likelihood of future losses in functional mobility. From the public health point of view, this study is an advantage, given the high prevalence of hearing and visual loss in the elders and the possibility that hearing and visual loss may be a potentially modifiable risk factor for physical decline.

The present study has some limitations, since the authors have participated in the data collection process, which means that the study cannot be considered blindness. There were several subjects to perform the data collections, which may have caused failures in the rigor of the collections. It can also lead to possible inter-observer variability. In the data collection there was an error in the collection of the TUG (contour of the obstacle instead of walking and turning with rotation of the body), which despite being the procedure for all subjects may have an influence on the times obtained and the consequent classification of the risk of fall. Finally, there is also a limitation the fact that a sample smaller than expected was reached, it does not have a normal distribution and the individuals under study are mostly institutionalized individuals.

CONCLUSION

From the results obtained, it can be concluded that the hypothesis initially raised "It is expected that there will be greater impairment in functional mobility in the elderly people with deficits in visual and or auditory acuity" is confirmed, since it is demonstrated by the results obtained and it is according to what is described in the scientific evidence.

This investigation may help to understand and clarify the relation between visual and auditory impairment and impaired functional mobility in the elderly people.

In this sense, it is interesting in future studies to continue to correlate these variables and to investigate TUG in more detail, since it is a reliable assessment tool to measure the functional mobility of the elderly people and there are few studies that use it directly related to the vision.

Given the increase in the number of elderly people worldwide, an early assessment and recognition of hearing and visual difficulties is necessary in order to reduce the likelihood of subsequent losses in functional mobility with a consequence in the number of declines.

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