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Effect of aging on timed balance test scores

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ABSTRACT

Background and purpose: Although tests of standing balance are frequently included in neurological evaluations, few objective data are available to indicate how well individuals of different ages should be able to maintain standing balance. The purpose of this study was: (1) to establish the relationship between performance on timed balance tests and age, and (2) to provide data for use in clinical assessments of patients from 20 – 69 years of age.

Subjects: Normal males and females (n=75) in the age group of 20-79 yrs were included in the study after they gave their informed consent.

Methods: The subjects were allocated to the five groups according to their age Group A (20-29 years), Group B (30-39 years), Group C (40-49 years), Group D (50-59 years) and Group E (60-69 years). The subject stood without shoes with weight bearing lower extremities inside 18- by 20- inches frame on a smooth and level surface. Subjects in each age group performed eight balancing activities and time was recorded for each activity on a digital stop watch.

Results: All subjects balanced for 30 seconds with feet 8 inches apart and with feet together both with their eyes open and with their eyes closed. One legged balance activities were not, however, accomplished for 30 seconds by all subjects. A significant negative correlation existed between the age and the time balanced on one leg with eyes open and closed.

Conclusion: The duration that individuals are able to maintain standing balance on one leg is highly related to age.

Key Words: Timed balance tests

INTRODUCTION

Equilibrioception or sense of balance is one of the physiological senses. It helps to prevent falling over when walking or standing still. Balance is defined as the ability to maintain the projection of the body's center of mass within manageable limits of the base of support, as in standing or sitting, or in transit to a new base of support, as in walking. According to Woollacott [1] balance can be defined as the ability to maintain the body's center of gravity over its base of support with minimal sway or maximal steadiness.

For many elderly subjects, the aging process is inevitably accompanied with restriction of the ability of independent movement and loss of balance [1]. The postural system consists of several sensory systems (somatosensory, visual and vestibular), the motor system and a central integrating control system, which involves complex interactions among multiple neural

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systems [2]. These systems are known to be affected by aging and result in an impairment of the ability to maintain stance [3]. Aging is associated with decline in the function of the sensory systems [3, 4, 5], with diminished muscle strength, decreased muscle volume and mass, loss of muscle fibers, alterations in the motor units, changes in posture and decreased balance control [6].

Adequate postural control depends on the integration of vestibular, somatosensory and visual information of the body motion [1]. Loss of sensitivity in peripheral sensory systems has been reported so frequently in the elderly without diagnosable disease that these losses are widely regarded as a normal consequence of aging [7].

The changes in the somatosensory, vestibular and visual systems have shown significant deterioration in these systems in older adults. Advancing age accompanied with a generalized reduction of the visual system and impaired vision has been associated with postural instability and increased risk of falls [4]. Comparison of older and younger subjects showed age-related decreases in vestibular function [8]**.** Adults above 70 years of age have a 40% reduction in sensory cells within the vestibular system [1]. Studies on age-related changes in the somatosensory system reflect a drop in the proprioceptive function of the elderly, a reduced vibration sense at the ankles [9] and changes in joint sensation [7].

Age is often accompanied by balance disorders or age-related pathologies, for example osteoarthritis, stroke, Parkinson's and Alzheimer's disease, which hinder independent mobility and lead to postural instability. It is estimated that one-third to one-half of the population over 65 years presents some problems with balance control, as shown in literature [10]. Since small balance impairment is a consequence of natural aging process, several authors showed that body sway increases with age [9, 11, 12]. For this reason, only a good knowledge of the effect of age on the stability of stance allows to differentiate between physiological aging and the pathologies leading to impaired balance control [3].

Tests of standing balance are frequently included in neurological evaluations, still few objective data are available to indicate how well individuals of different ages should be able to maintain standing balance. Even balance tests, for which maximum timed end points (5 – 75 seconds) are established, do not specifically support the clinical appropriateness of the end points or support with objective data their description of changes in the capacity of older individuals to perform timed balance tests [13, 14]. For example Potvin and Tourtellotte [15, 16] claimed that all young adult, healthy subjects can balance on one leg for 30 seconds with eyes closed, but they offered no data to support their claim. Studies often included comparison of the ability to maintain stance for groups of young and older people only [6, 9 17] or compared middle-aged and elderly people [5], or include only a single age group [4].

Clearly, if clinicians are to use balance tests as a part of neurological evaluations, they need tests that are objective and for which age-related data are available. The purpose of this study was: (1) to establish the relationship between performance on timed balance tests and age, and (2) to provide data for use in clinical assessments of patients from 20 – 69 years of age. Like sway, performance on timed balance tests was expected to be significantly correlated with age.

Previous studies have not given conclusive evidence in favor or against "decreased timed balance test scores with aging". So the topic certainly begs further investigations.

METHODS

Normal males and females (n=75) in the age group of 20-69 yrs were included in the study after they gave their informed consent. Subjects were excluded from the study if they were unable to follow instructions or had vertigo, any neurological diagnosis that could account for possible loss in balance and falls such as CVA, Parkinson's disease, cardiac problem, TIA, multiple sclerosis, orthopaedic dysfunction of trunk and lower extremities such as fracture, surgery, lower limb joint replacements, were undergoing balance training or strength training for lower limb, were unable to walk without an assistive device, were dependent in activities of daily living. Subjects were then assigned into 5 age groups.

Group A - Age 20-29 years

Group B - Age 30-39 years

Group C - Age 40-49 years

Group D - Age 50-59 years

Group E - Age 60-69 years

Every subject in each group performed the eight balancing activities and the goal of each activity was to maintain balance for 30 seconds. The subject stood without shoes with weight bearing lower extremities inside 18- by 20- inches frame on a smooth and level surface. Subjects in each age group performed eight balancing activities and time was recorded for each activity on a digital stop watch. Each subject was permitted five attempts per activity to reach the 30-second goal. If the subject reached this goal, we recorded a time of 30 seconds. If the subject did not reach his goal, we recorded the best of the five timed trials.

Subjects performed the following balancing activities:

1. balancing on two legs, with the feet 8 inches apart (first with eyes open and then with eyes close).
2. balancing on two legs, with the feet together (first with eyes open and then with eyes close).
3. balancing on right leg (first with eyes open and then with eyes close).
4. balancing on left leg (first with eyes open and then with eyes close).

All subjects performed two-legged activities before the one-legged activities. They were allowed to rest as necessary and to alternate between legs as they wished during one-legged balance. If any of the following events occurred before 30 seconds had lapsed, we stopped the timed trial and noted the time:

a. during two legged balance, any displacement of the feet on the floor;
b. during one legged balance, any use of the arms or the contra lateral leg for support such as bracing the non-weight bearing lower extremity against the weight bearing lower extremity, hopping on the weight bearing lower extremity, or moving the weight bearing lower extremity outside the confines of the frame; and
c. opening the eyes during the eyes closed activities.

RESULTS

Although a few old subjects required more than a single trial, all subjects balanced for 30 seconds with feet 8 inches apart and with feet together both with their eyes open and with their eyes closed. One legged balance activities were not, however, accomplished for 30 seconds by all subjects. The test results for the 5 groups are summarized in table: 1.

The mean duration that one legged balance could be maintained was longer with the eyes open than with the eyes closed. Similarly a larger percentage of subjects failed to balance for 30 seconds with the eyes closed than with the eyes open (Fig 1 and 2).

The mean amount of time subjects could maintain balance on one leg and the percentage of subjects balancing for 30 seconds diminished with age (Fig 1 and 2). A significant relationship existed between the age and time balanced on one leg with eyes open and closed when analyzed using a Pearson product moment correlation test (Fig 3, 4, 5, 6) and table 2.

DISCUSSION

Although tests of standing balance are frequently included in neurological examinations, few objective data are available to indicate how well individuals of different ages should be able to maintain standing balance. This study presents objective information regarding standing balance. Such objective documentation should allow the clinician to make better judgments. We choose to study healthy people who functioned independently without assistive devices in the

TABLE 1: Comparison of variables in different age groups.

	GROUP A Mean(SD)	GROUP B Mean(SD)	GROUP C Mean(SD)	GROUP D Mean(SD)	GROUP E Mean(SD)
Time (in seconds) for balancing on two legs with feet 8 inches apart Eyes open	30(0)	30(0)	30(0)	30(0)	30(0)
Time (in seconds) for balancing on two legs with feet 8 inches apart Eyes close	30(0)	30(0)	30(0)	30(0)	30(0)
Time (in seconds) for balancing on two legs with feet together Eyes open	30(0)	30(0)	30(0)	30(0)	30(0)
Time (in seconds) for balancing on two legs with feet together Eyes close	30(0)	30(0)	30(0)	30(0)	30(0)
Time (in seconds) for balancing on right leg Eyes open	29.68 (0.94)	26.69 (2.31)	21.31 (3.14)	17.29 (1.46)	11.81 (3.54)
Time (in seconds) for balancing on right leg Eyes close	24.79 (2.79)	21.11 (7.76)	17.40 (3.75)	8.95 (3.10)	4.45 (1.19)
Time (in seconds) for balancing on left leg Eyes open	28.26 (3.97)	20.66 (5.27)	17.27 (4.43)	15.37 (2.08)	9.53 (3.14)
Time (in seconds) for balancing on left leg Eyes close	16.91 (3.57)	12.09 (6.47)	8.74 (3.94)	3.43 (1.85)	2.38 (1.10)

Table 2 : Correlation between the age and time balanced on one leg

Variable	r	p
Time for balancing on right leg Eyes open	- 0.951	< 0.01
Time for balancing on right leg Eyes close	- 0.921	< 0.01
Time for balancing on left leg Eyes open	- 0.858	< 0.01
Time for balancing on left leg Eyes close	- 0.829	< 0.01

Fig. 1: Time for Balancing on Right Leg (Eyes Open and Close)

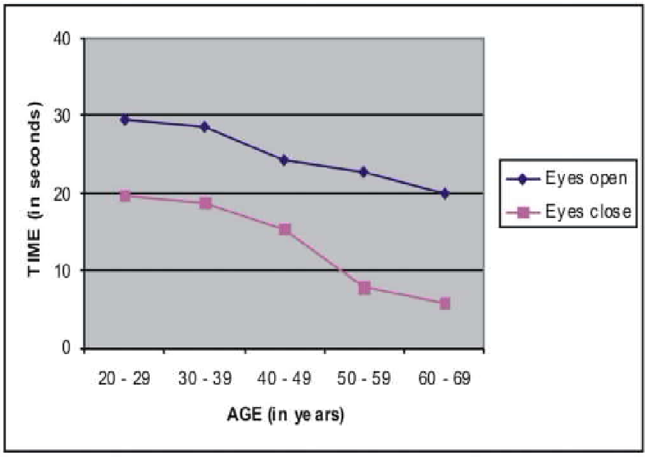


Fig. 2: Time for Balancing on Left Leg (Eyes Open and Close)

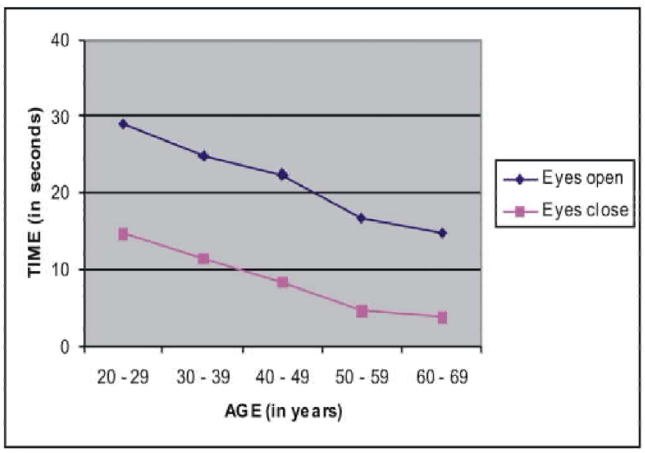


Fig. 3: Correlation between Age and Right Leg Balance Scores (Eyes Open)

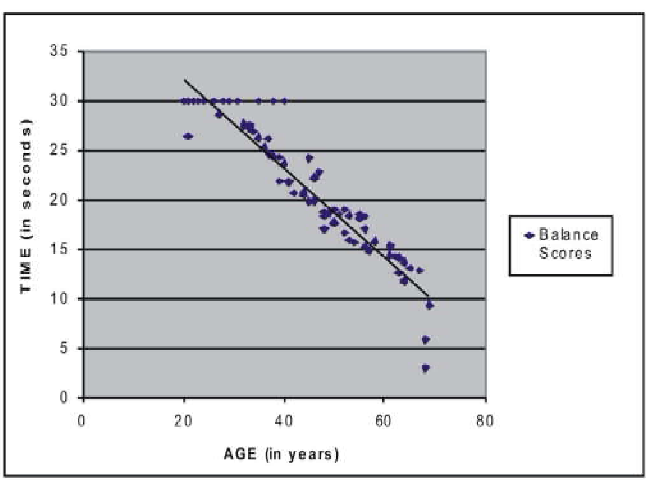


Fig. 4: Correlation between Age and Right Leg Balance Scores (Eyes Close)

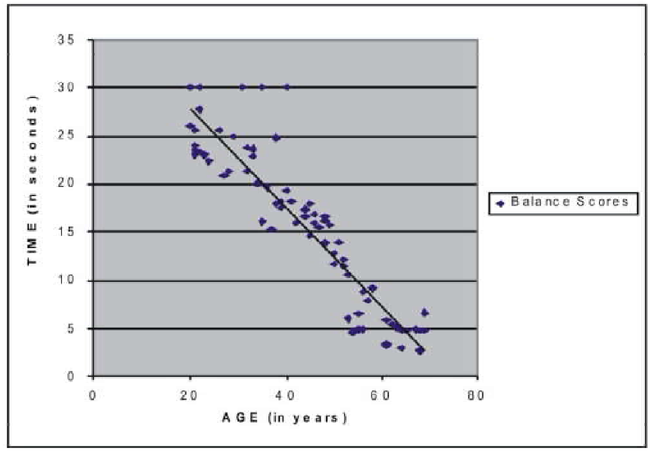


Fig. 5: Correlation between Age and Left Leg Balance Scores (Eyes Open)

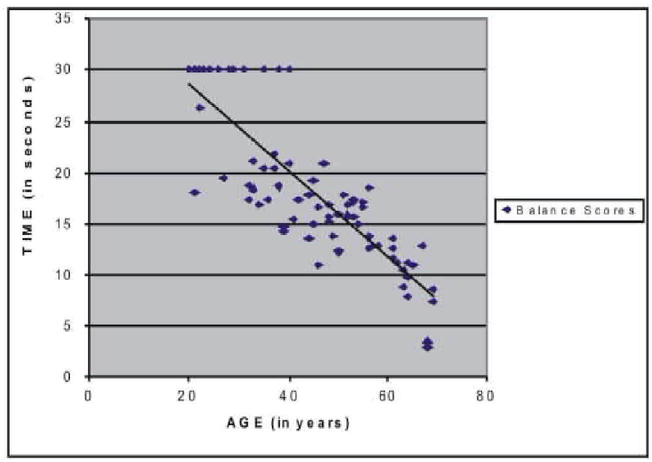
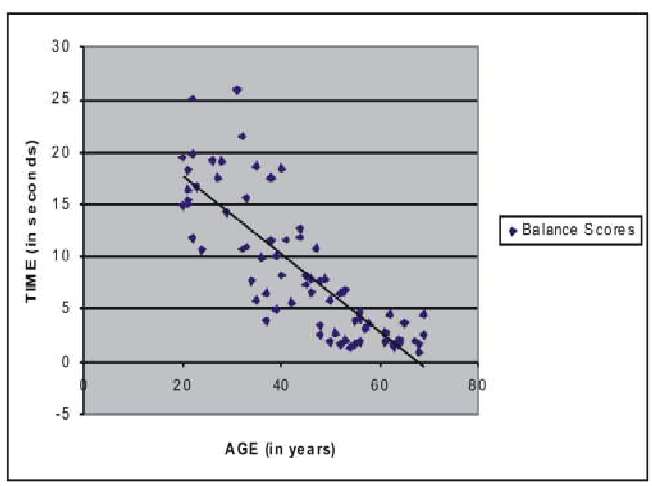


Fig. 6: Correlation between Age and Left Leg Balance Scores (Eyes Close)



community as they presented a more realistic standard of comparison for the elderly people seen by physical therapists. They represented a population who were fairly active and had fairly good health, in spite of presence of some pathology. All for tests in this study showed a trend toward age-related declines. These preliminary data suggest the need for using age related data in order to make judgments for older adults.

Our findings suggest that an inability to maintain balance for 30 sec while the feet are together is abnormal, whether the eyes are open or closed in individuals from 20-69 years of age. This finding is consistent with the report of Potvin and Tourtellotte [15, 16]. Romberg's sign, the tendency to sway and fall when the eyes are closed and the feet approximated, can legitimately be considered demonstrative of an abnormal state in patients younger than 69 years of age.

The mean time scores reported for one-legged balance in this study are somewhat lower, at least in the younger age group, than they would have been if an upper limit of 30 seconds had not been established. Analysis demonstrates an inverse relationship between age and balance. This suggests that grouping according to age is required if normative data is to be obtained.

The findings are in agreement with previous studies examining balance during quiet stance showing increased body sway in the elderlies [3, 9, 11, 17]. It is known that the body sway increases also with deficit of information from one of the sensory systems: visual, vestibular or somatosensory[4]. We found that the values increased significantly in the absence of visual information (with eyes closed) in each age group examined. Interesting to note is that the combination of sensory deficit (visual, somatosensory or both) with advancing age is likely responsible for the postural instability.

Jonsson [18] identified two distinct postural phases that are necessary to perform single leg stance. During the dynamic phase, there was a rapid decrease of force variability amplitude as the subjects made postural adjustments to regain standing balance after transferring weight to one leg. The change in force amplitude occurred within the first five seconds of testing. During the second phase, static postural equilibrium was required to maintain balance on one foot, and the force variability was minimal. They concluded that elderly subjects had difficulty maintaining balance in the static phase due to difficulty adjusting postural control during the initial dynamic phase of one-leg stance. Another possibility for the decrease in stance times for elderly subjects is a decrease in lower extremity muscular strength and endurance.

The limited number of subjects in the study prevents the use of these results as true normative values for balance, as does the nature of the sample (i.e., volunteers rather than randomly selected subjects). The information does, none the less, indicate the level of balance for subjects of different ages.

Whether the ability to balance as tested is related to functional capacity awaits further testing. This relationship and testing of the benefits of balance exercises, which have been advocated for increasing postural control, increasing confidence, and preventing falls [19], are areas worthy of future research.

CONCLUSION

Our study results show that the balance scores decrease with increasing age. The duration that individuals are able to maintain standing balance on one leg is highly related to age. The practical implication of this information in patient assessment is that performance in timed tests is age specific and that the clinician's expectations for patients should be based on the patient's age.

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