Library Progress International
Vol.44, No.5, Jul-Dec 2024: P. 441-447

Print version ISSN 0970 1052
Online version ISSN 2320 317X

Original Article

Available online at www.bpasjournals.com

Evaluation and comparison of Senegalese boys aged 7 to 12 maximum walking speed

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How to cite this paper as: Mountaga Diop, Papa Serigne Diène, Mame Ngoné Bèye, Ndiack Thiaw, Ndarao Mbengue, El Hadji Mamouthiam Diop, Amadou Diouf, Thierno Diouf, Daouda Diouf, Maoundé Sakho, Abdoulaye Ba, Abdoulaye Samb (2024) Evaluation and comparison of Senegalese boys aged 7 to 12 maximum walking speed. Library Progress International,44(5).441-447

ABSTRACT

Introduction: Walking in children, can be altered as a result of accidents or illnesses. These changes can be long-lasting and can even render the child unable to walk.

Rehabilitation doctors in Africa in general, and in Senegal in particular, do not have benchmarks enabling them to assess the degree to which a child's maximum walking speed has been recovered at the end of rehabilitation.

Objective

To assess and compare the maximum walking speed of Senegalese boys aged 7 to 12.

Materials and methods

One hundred and eighty Senegalese boys were divided into 6 age groups of thirty children. Each child walked as fast as possible over a flat distance of 15m delimited by photoelectric cells. For each child, the average maximum walking speed was calculated from the three recorded trials. The average maximum speed for each child was used to determine the averagemaximum walking speed for each group of children. The mean maximum speed and the meanmaximum speed related to the length of the lower limb of the 6 groups were compared two bytwo using Student's t test.

Results

The mean maximum walking speed of seven-year-olds (2.17 m/s ±0.26) was significantly (P

<0.05) slower than those of the other five groups. The walking speed of nine-year-olds was significantly lower than that of ten- and eleven-year-olds. The walking speed of twelve-year- olds was significantly higher than that of ten- and eleven-year-olds.

Relative to the length of the lower limb, the walking speed of ten- and eleven-year-olds is significantly greater than that of seven- and eight-year-olds.

Conclusion

The maximum walking speeds for children aged seven, eight, nine, ten, eleven and twelve were 2.17m/s, 2.37m/s, 2.38m/s, 2.59m/s, 2.62m/s and 2.79m/s respectively.

The average maximum walking speed of the seven-year-olds was significantly lower than thatof the other five groups,

With the exception of nine-year-olds, the average maximum walking speed of twelve-year- olds was significantly higher than that of children in the other groups.

1. Introduction

People walk during the course of a normal day, whether for work or recreation [Astrand, 1972]. Walking is a fundamental need for daily activity [Pratt, 1994] and one of the most universal and complex human activities. It enables people to move

from one environment to another.

It is a complex motor skill controlled by several interconnected nerve pathways coming from the cortex and reaching the muscles [Pratt, 1992]. Walking is also an exercise that enables us to carry out activities such as work; it also enables us to interact with the surrounding environment. By walking, people are in constant contact with those around them. Walking therefore enables people to integrate into society and discover nature.

In children, walking can be altered as a result of prenatal or neonatal accidents or illnesses. This loss, sometimes, follows the child as it grows, eventually rendering it unable to walk and creating a handicap in carrying out daily activities.

Rehabilitation doctors in Africa in general, and in Senegal in particular, do not have benchmarks enabling them to assess the degree to which a child's maximum walking speed has been recovered at the end of rehabilitation.

Most studies on walking in healthy children, and on walking speed in particular, have been carried out on European and American children. In Africa in general, and in Senegal in particular, our rehabilitation doctors find it very difficult to know whether their patients have regained their maximum walking speed after treatment. This problem is linked to the lack of adequate equipment for studying walking, and also to the lack of data on maximum walking speed from African children.

We therefore propose to carry out a study with the aim of evaluating and comparing the maximum walking speed of Senegalese boys aged between seven (7) and twelve (12) years. This study will enable us to provide values that will serve as benchmarks for Senegalese rehabilitation doctors to determine whether the patient has recovered his maximum walking speed at the end of his treatment.

2. Methodology

2.1 Study sample

Our study sample consisted of 180 school-going boys aged 7 to 12, divided into six groups of 7-year-olds (G1), 8-year-olds (G2), 9-year-olds (G3), 10-year-olds (G4), 11-year-olds (G5) and 12-year-olds (G6).

Excluded from the study were female children, children suffering from an illness or disability,and children with a medical history (delayed acquisition of walking ability, accident). Also excluded from the study were children under the age of 7 and those over the age of 12.

2.2 Materials

To carry out our study, we used:

-A Pro-Tech decameter to measure the distance to be walked,

-a Fox whistle to give the signal for the walk test,

-Brower standard Kit photocells, comprising two pairs of photocells, four telescopic tripodsand an automatic stopwatch to record the time taken during the walk test.

3. Methods

The aim of our study was to evaluate and compare the maximum walking speed of Senegaleseboys aged 07 to 12 years.

3.1 Description and procedure for the 15m walk test

It consists of a walking test over a flat distance of 15 meters. During this test, the boy tries to complete the distance as quickly as possible. In short, he tries to complete the distance in record time, while respecting the criteria for valid walking. The test is validated if the child is regularly in contact with the ground, which differentiates walking from running, during which there is a moment when both feet are off the ground - the take-off phase.

As soon as the child behind the start line reaches the first photoelectric cell, the two automaticstopwatches in the two photoelectric cells (the one at the start line and the other at the finish line) start counting down the time. As soon as the child crosses the finish line, the stopwatches in the photoelectric cells are activated and display the time taken by the child over the distance.

When child 1 finishes his trial, child 2, who was behind him at the start, takes off after child 1's time has been recorded and the photocells reset to zero.

This continues until the thirtieth child in the test group. When the child № 30 finishes his trial,the second trial is started by the child №1. At the end of the second trial, the children perform the third trial. The children are then escorted back across the road and back to their schools as requested by the head teachers.

3.2 Measuring the length of the lower limb

The subject stands with feet together. The zero line of the tape measure is fixed on the iliac crest of the right lower limb. The tape is then lowered until the hand touches the lateral (outer)malleolus and the length of the lower limb is read.

3.3 Statistical processing

After each trial, the speed is calculated by dividing the distance by the time:V(m/s) = D(m)/ T (s)

If the child's three trials are validated, we obtain three speeds: V1, V2 and V3. The child's maximum walking speed is obtained by averaging the three speeds.The child's average V (m/s) = (V1 +V2+V3)/3.

This gives the average speeds (Vm1, Vm2. Vm30) of the thirty children in each group.

The average maximum walking speed for the group of thirty children is obtained as follows:VmG = (Vm1+Vm2+Vm3+ +Vm30) /30.

This gives the average maximum walking speeds for the 6 groups of children.

We also calculated the average length of the lower limb for each group of children.

We compared the mean variables of the groups in pairs using Student's t-test after checking that the variances were equal. Our probability of error α is set at 5%, i.e. the error we accept in deciding on the difference that exists between the means of the two groups compared according to the following hypothesis:

Ho: there is no statistically significant difference between the two mean values compared.

If the probability of error P found in the Student test is less than α, the hypothesis is rejected:in other words, there is a statistically significant difference between the two averages compared.

If the probability of error P found in the Student test is greater than α, the hypothesis is confirmed: there is no statistically significant difference in mean between the two groups compared.

4. Results

1: Comparison of average lower limb length values for the six groups

Table 1: Comparison of the average length of the lower limb in group 1 with those of the other groups

Groups Compared two by two	Fixed probability: 0,05	Probability found: P	Average lengths(cm) of the lower limb	Comments
G1 and G2	0,05	4,82	G1=62,53±3,52 G2=68,05±5,16	NS
G1 and G3	0,05	0,003	G1=62,53±3,52 G3=65,83±5,75	S
G1 and G4	0,05	4;75	G1=62,53±3,52 G4=69,70±4,62	NS
G1 and G5	0,05	1,69	G1=62,53±3,52 G5=70,03±4,99	NS
G1 and G6	0,05	2,18	G1=62,53±3,52 G6=80,63±5,49	NS

Table 2: Comparison of the average length of the lower limb in Group 2 with that of the othergroups

Groups compared two by two	Fixed probability:0, 05	Probability found: P	verage lengths (cm) of the lower limb	Comments
G2 and G3	0,05	0,13	G2=68,00±5,16 G3=65,83±5,75	NS
G2 and G4	0,05	0,18	G2=68,00±5,16 G4=69,70±4,62	NS
G2 and G5	0,05	0,13	G2=68,00±5,16 G5=70,03±4,99	NS
G2 and G6	0,05	1,41	G2=68,00±5,16 G6=80,63±5,49	NS

Table 3: Comparison of the average lengths of the lower limb in groups 3, 4, 5 and 6.

Groups Compared two by two	Fixed probability: 0,05	Probability found: P	Average length (cm) of the lower limb	Comments
G3 and G4	0,05	0,001	G3=65,83±5,75 G4=69,70±4,62	S
G3 and G5	0,05	0,001	G3=65,83±5,75 G5=70,03±4,99	S

G3 and G6	0,05	1,41	G3=65,83±5,75 G6=80,63±5,49	NS
G4 and G5	0,05	0,32	G4=69,70±4,62 G5=70,03±4,99	NS
G4 and G6	0,05	2,24	G4=69,70±4,62 G6=80,63±5,49	NS
G5 and G6	0,05	3,99	G5=70,03±4,99 G6=80,63±5,49	NS

2: Comparison of the average maximum walking speeds of the 6 groups

Table 4: Comparison of the average maximum walking speed of group 1 with those of theother groups

Groups Compared two by two	Fixed probability: 0,05	Probability found: P	Average maximum walking speed (m/s)	Comments
G1 and G2	0,05	0,0009	G1=2,17±0,26 G2=2,37±0,27	S
G1 and G3	0,05	0,01	G1=2,17±0,26 G3=2,38±0,29	S
G1 and G4	0,05	1,87	G1=2,17±0,26 G4=2,59±0,33	S
G1 and G5	0,05	4,93	G1=2,17±0,26 G5=2,62±0,31	S
G1 and G6	0,05	2,46	G1=2,17±0,26 G6=2,79±0,36	S

Table 5: Comparison of the average maximum walking speed of group 2 with those of theother groups

Groups Compared two by two	Fixed probability : 0,05	Probability found: P	Average maximum walking speed (m/s)	Comments
G2 and G3	0,05	0,78	G2=2,37±0,27 G3=2,38±0,29	NS
G2 and G4	0,05	0,01	G2=2,37±0,27 G4=2,59±0,33	S
G2 and G5	0,05	7,59	G2=2,37±0,27 G5=2,62±0,31	NS
G2 and G6	0,05	6,04	G2=2,37±0,27 G6=2,79±0,36	S

Table 6: Comparison of average maximum walking speeds for groups 3, 4, 5 and 6

Groups Compared two by two	Fixed probability: 0,05	Probabilityfound: P	Average maximum walking speed (m/s)	Comments
G3 and G4	0,05	0,0008	G3=2,38±0,29 G4=2,59±0,33	S
G3 and G5	0,05	0,0004	G3=2,38±0,29 G5=2,62±0,31	S

G3 and G6	0,05	1,87	G3=2,38±0,29 G6=2,79±0,36	NS
G4 and G5	0,05	0,65	G4=2,59±0,33 G5=2,62±0,31	S
G4 and G6	0,05	0,005	G4=2,59±0,33 G6=2,79±0,36	S
G5 and G6	0,05	0,029	G5=2,62±0,31 G6=2,79±0,36	S

3: Comparison of mean values of maximum walking speed in relation to the length ofthe lower limb in the six groups

Table 7: Comparison of the average maximum walking speed in relation to the length of thelower limb in group 1 with those of the other groups

Groups Compared twoby two	**Fixed probability: 0,05**	**Probabilityfound: P**	**Average maximum walking speed in relation to the length of the lower limb (m/s)**	**Comments**
G1 and G2	0,05	0,902	G1=3,48±0,43 G2=3,49±0,32	NS
G1 and G3	0,05	0,175	G1=3,48±0,43 G3=3,65±0?49	NS
G1 and G4	0,05	0,031	G1=3,48±0,43 G4=3,73±0?34	S
G1 and G5	0,05	0,031	G1=3,48±0,43 G5=3,76±0?33	S
G1 and G6	0,05	0,911	G1=3,48±0,43 G6=3,47±0,43	NS

Table 8: Comparison of the average maximum walking speed in relation to the length of thelower limb in group 2 with those of the other groups.

Groups Compared Two by two	Fixed probability: 0,05	Probability found: P	Average maximum walking speed in relation to the lengthof the lower limb (m/s)	comments
G2 and G3	0,05	0,902	G2=3,49±0,32 G3=3,65±0?49	NS
G2 and G4	0,05	0,175	G2=3,49±0,32 G4=3?73±0?34	S
G2 and G5	0,05	0,031	G2=3,49±0,32G5=3?76±0?33	S
G2 and G6	0,05	0,031	G2=3,49±0,32 G6=3,47±0,43	NS

Table 9: Comparison of average maximum walking speed in relation to the length of thelower limb in groups 3, 4, 5 and 6

Groups Compared two by two	Fixed probability : 0,05	Probability found: P	Average maximum walking speed in relation to the length of the lower limb (m/s)	comments

G3 and G4	0,05	0,467	G3=3,65±0,49 G4=3,73±0,34	NS
G3 and G5	0,05	0,289	G3=3,65±0,49 G5=3,76±0,33	NS
G3 and G6	0,05	0,182	G3=3,65±0,49 G6=3,47±0,43	NS
G4 and G5	0,05	0,742	G4=3,73±0,34 G5=3,76±0,33	NS
G4 and G6	0,05	0,013	G4=3,73±0,34 G6=3,47±0,43	S
G5 and G6	0,05	0,024	G5=3,76±0,33 G6=3,47±0,43	S

5. Discussion

The mean maximum walking speed of the seven-year-olds (2.17±0.26m/s) was significantly($P < 0.05$) lower than those of the other five groups (Table 4).

If we focus on the average maximum walking speed of nine-year-olds (2.38±0.29m/s), this is significantly lower than that of ten-year-olds (2.59±0.33m/s) and eleven-year-olds (2.62±0.31) (table.6.).

If we compare ten-year-olds (2.59±0.33), eleven-year-olds (2.62±0.31m/s) and twelve-year- olds (2.79±0.36m/s) with one another, we find that the average maximum walking speed of twelve-year-olds is significantly higher (Table 6).

These results are consistent with those of Burnett [1971], Takégami [1992], Katoch [1993], Gorton [1997] and Oeffinger [1997] who accepted that children of different ages walk at different speeds. However, some of our results would appear to contradict those of the above authors, as the mean maximum walking speed of eight-year-olds (G2) was not significantly ($P<0.05$) lower than that of nine-year-olds (G3) and eleven-year-olds (G5) (Table 5).

Furthermore, the average maximum walking speed of nine-year-olds (2.38±0.29m/s) was not significantly different from that of twelve-year-olds (2.79±0.36m/s), ten-year-olds (2.59±0.33m/s) and eleven-year-olds (2.62±0.31m/s). This discrepancy could be explained by the fact that some children did not actually walk at their maximum speed. They may have been distracted by the photocells.

Relative to the length of the lower limb, the maximum walking speed of ten-year-olds (3.73±0.34) and eleven-year-olds (3.76±0.44) was significantly higher than that of seven- year-olds (3.48±0.43) and eight-year-olds (3.49±0.32).

To our great surprise, the walking speed in relation to the length of the lower limb of twelve- year-olds (3.47±0.43) was significantly lower than that of ten-year-olds (3.73±0.34) and eleven-year-olds (3.76±0.44).

If we compare the maximum walking speed in relation to the length of the lower limb of seven-year-olds with that of eight-year-olds and nine-year-olds, there is no significant difference (table 7). The same is true between eight-year-olds and twelve-year-olds (table 8), between nine-year-olds and twelve-year-olds (table 9) and between ten-year-olds and eleven- year-olds (table 9).

We used lower limb length as the geometric normalization factor because it is more closely related to lower limb function than height [Sutherlansd, 1988].

However, Sutherland [1980] recommends reserving this normalization for children aged four and over in order to avoid changes in the spatial and temporal parameters influenced by the maturation of the central nervous system.

Conclusion

The aim of our study was to evaluate and compare the maximum walking speed of 180 Senegalese boys aged between seven and twelve, divided into 6 age groups of 30 children.

We measured each child's maximum walking speed over a distance of 15m. We then compared the average maximum walking speed and the average maximum walking speed in relation to the length of the lower limb of the six groups, in pairs, using Student's T-test.

This study shows that:

-the maximum walking speeds for children aged seven, eight, nine, ten, eleven and twelve are2.17m/s, 2.37m/s, 2.38m/s, 2.59m/s, 2.62m/s and 2.79m/s respectively,

-The average maximum walking speed of seven-year-olds was significantly lower than that ofthe other five groups,

- With the exception of nine-year-olds, the average maximum walking speed of twelve-year-olds was significantly higher than that of children in the other groups.

-As for the length of the lower limb, the maximum walking speed of ten-year-olds andeleven-year-olds is significantly higher than that of seven-year-olds and eight-year-olds,

Regarding the length of the lower limb, the maximum walking speed of twelve-year-olds(3.47±0.43) was significantly lower than that of ten-year-olds and eleven-year-olds.

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