Age Influences Step Length to Cadence Relationship during Treadmill Walking at Different Speeds

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Summary

Step length to cadence relationship (SL-CADrel) is an important factor in walking motor control. This relationship was examined across three walking speeds among three age groups. Regardless of age, most participants increased step length more than cadence to accommodate increased walking speed. Interestingly, a positive linear SL-CADrel was found with increasing walking speed in the young and middle age groups, but not in the older age group suggesting altered walking motor control strategies with aging.

Introduction

In studies of overground walking, step length and cadence have been shown to have a linear relationship (SL-CADrel) across walking speeds [1,2] and age [1], though this relationship is nonlinear when either a set cadence or stride length are enforced [1]. This suggests use of an "automated" motor control strategy requiring little attentional control during free walking at different speeds [1]. It is unknown how individuals across age adapt their step length and cadence to accommodate different speeds during treadmill walking. The method chosen to increase walking speed (step rate, step length, or a combination) may impose unique biomechanical demands affecting the SL-CADrel [3].

Methods

Healthy adults were recruited across three age groups: young (n = 20, aged 19-35), middle (n = 12, aged 42-56), and old (n = 15, 60-75). After completing a standardized warm-up to identify preferred gait speed while walking, participants underwent gait analysis on an instrumented treadmill. This preferred speed was used to calculate the following treadmill conditions: preferred speed, 10% below preferred speed, and 10% above preferred speed. Participants walked for 5 minutes at each speed. Cadence and step length were captured during the last minute of each condition. Each participant was classified into one of three groups based on whether they increased their walking speed by primarily increasing their cadence, primarily increasing their step length, or using a mix of both strategies. [3] A chi-square test was used to compare the proportions of participants in each age group who used each of the three methods to increase gait speed. Additionally, linear regression models were used to test if the relationship between step length and cadence with increasing gait speed was linear in each age group.

Results and Discussion

Most participants in all age groups used a step length method to increase their gait speed (Table). The proportion of participants employing the step length method was greater compared to similar studies conducted overground [3]. Additionally, the proportion of participants using each method was not different across age groups (p = 0.86). A positive linear SL-CADrel was found for the young (R^2=0.58) and middle (R^2=0.59) age groups, but not the old age group (R^2=0.09) (Figure). This difference is not consistent with previous research [1], suggesting individuals in the old age group are using more attentional control and not using an automated strategy to accommodate different gait speeds during treadmill walking.
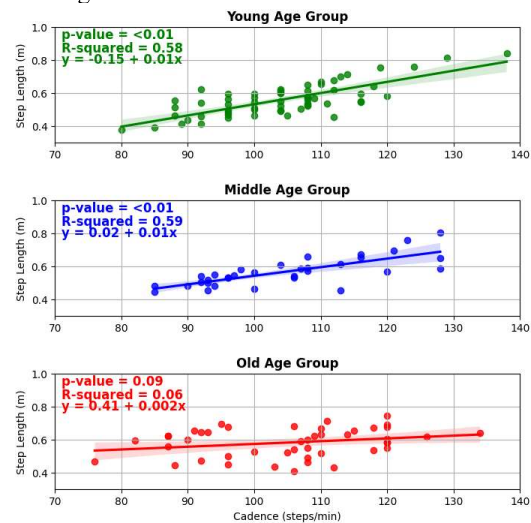

Figure: Step length to cadence relationship by age group.

Conclusions

Participants predominantly used a step length method to achieve faster walking speed on a treadmill, which differs from previous work overground. The young and middle age groups demonstrated a positive linear relationship between step length and cadence across different gait speeds, while the older age group did not, suggesting altered walking motor control strategies with aging.

References

[1] Egerton T. (2011) *Gait Posture*, **34**: 178-182.
[2] Zijlstra W. (1995) *Gait Posture* **3**, 13-18.
[3] Ardestani M. (2016) *Gait Posture*, **46**: 118-125

Table: Number of subjects by age group using each method to increase speed (expressed as number (percent of age group)).

	Cadence Method	Step Length Method	Combination Method	χ^2 = 1.28, p = 0.86
Young Age Group	4 (20%)	12 (60%)	4 (20%)	
Middle Age Group	1 (8%)	9 (75%)	2 (17%)	
Old Age Group	2 (13%)	11 (73%)	2 (13%)	