Gait Kinetics of 7 Year-old Children: A Comparison to Adults Using Age-Specific Anthropometric Data

K.J. Ganley, C.M. Powers
University of Southern California, Los Angeles, CA 90033

Introduction

It has been reported that gait kinematics of children are similar to those of adults by 3 ½ - 4 years of age,[1] however, the underlying kinetics may differ in children ≤ 8 years.[2] It has been suggested that these differences are the result of the use of anthropometric data that do not accurately represent the body proportions of children.[2] Using age-specific anthropometric data obtained from dual energy x-ray absorptiometry,[3,4] the purpose of this study was to determine if sagittal plane gait kinetics of 7 year-old children differ from those of adults.

Statement of Clinical Significance

An understanding of normal gait in children is essential for the identification of deviations from normal and the design of effective rehabilitation strategies for gait-related disabilities.

Methods

Fifteen 7 year-old children and fifteen adults participated in this study. Three-dimensional kinematics (VICON; 60 Hz) and ground reaction forces (AMTI; 120 Hz) were recorded while subjects walked at self-selected speeds. Sagittal plane moments for the hip, knee, and ankle (inverse dynamics) were calculated using age-specific, DXA-derived anthropometric proportions.[3,4] Joint power was calculated as the dot product of the net joint moment and angular velocity. Independent *t*-tests were used to compare peak joint angles, moments, and power. A significance level of 0.002 was used to correct for multiple comparisons.

Results

No significant differences in joint kinematics were observed at the hip, knee, or ankle (Figures 1a,b,c). While no differences in kinetics were observed at the hip or knee (Figures 1d,e,g,h), peak ankle plantarflexor moments and peak ankle power absorption and generation in late stance were significantly less in the 7 year-olds compared to adults (Figures 1f,i). Post-hoc analysis (Pearson correlation coefficient) revealed a strong positive correlation (r=0.80) between peak ankle plantarflexor moment and foot length (Figure 2).

Discussion

The results of this study demonstrated that when using age-specific anthropometric data the gait kinetics of 7 year-olds were similar to those of adults for most of the variables examined, however differences were observed at the ankle. Although kinetic differences have been attributed to neuromuscular immaturity,[5] our data revealed that 64% of the variance in plantarflexor moment could be explained by foot length. This can be explained by the fact that during late stance, foot length is a primary determinant of the moment arm of the vertical ground reaction force and suggests that physical factors, rather than neuromuscular immaturity, may explain the differences in ankle kinetics. In conclusion, these data suggest that gait kinematics and kinetics of 7-year old children are comparable to adults, however consideration should be given to normalizing ankle moments to foot length as this physical parameter may influence ankle kinetics (including power).

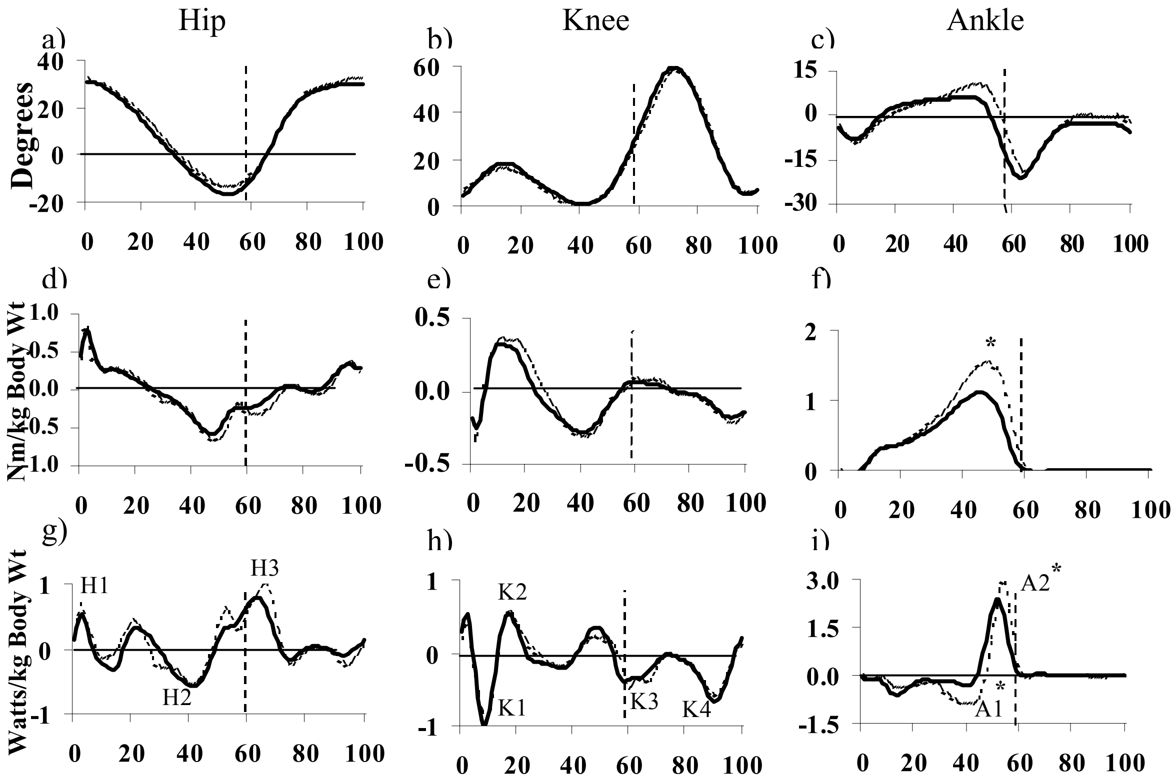

Figure 1. Joint angles (a-c), moments (d-f), and power (g-i) at the hip, knee, and ankle for adults (dotted line) and 7 year-olds adults (solid line) normalized to body weight and 100% of the gait cycle. Vertical lines delineate stance from swing. * indicates p<0.002.

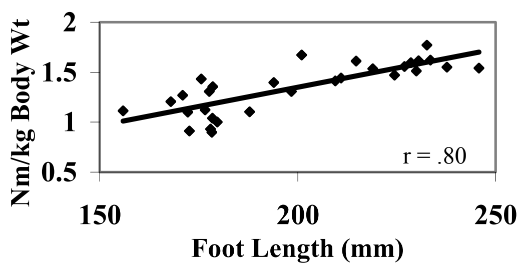

Figure 2. Scatterplot illustrating the relationship between peak ankle plantarflexor moment and foot length across subjects.

References

1 Sutherland DH, et al. J Bone Joint Surg [Am] 1980; 62:336-353.
2 Cupp T, et al. J Pediatr Orthop 1999; 19:475-478.
3 Ganley KJ, Powers CM. Gait and Posture 2001; 13:271-272 (abstract).
4 Ganley KJ, Powers CM. Gait and Posture 2002; 16 (abstract).
5 Sutherland DH. Gait and Posture 1997; 6:163-170.