

# How Children Walk: Bout Length during Real-World Locomotor Behavior

Michael S. Orendurff<sup>1</sup>, Vy K. Do<sup>1</sup>, Carol Newman<sup>2</sup>, Ashley A. Williams<sup>3</sup>

<sup>1</sup>Movement Science Laboratory, Texas Scottish Rite Hospital for Children, Dallas, TX, USA

<sup>2</sup>St Pius X School, Dallas, TX, USA

<sup>3</sup>Department of Biomedical Engineering, Washington University, St. Louis, MO, USA  
email: michael.orendurff@tsrh.org, web: www.TSRHC.org

## INTRODUCTION

The sustained scientific effort to investigate human locomotion has led to a detailed understanding of the three dimensional joint kinematics and kinetics associated with normal and pathological gait. However, it is still not known how technical gait deficits impact the ability to meet the challenges of everyday community mobility. As a first step toward understanding the community mobility demand, this investigation aims to define the duration of locomotor bouts performed by typically developing adolescent children.

## METHODS

Forty children (age 12 years and 6 months  $\pm$  18 months) gave informed assent and their parents gave informed consent to participate in this IRB-approved study. Each child wore a StepWatch Activity Monitor (SAM; OrthoCare Innovations, Mountlake Terrace, WA, USA) on their ankle for fourteen days. SAMs were programmed for each individual's height and collected all steps in each 10 second time interval. Custom code (Sadaka, LLC, Huntington Beach, CA, USA) counted sequential steps to define the length of each locomotor bout (number of steps before stopping)[1]. A frequency distribution was calculated by partitioning the length of locomotor bouts (the number of steps in a row before stopping) into a quasi-log scale

of 2-9, 10-19, 20-49, 50-99, 100-199, 200-299, 300-499, 500-999, 1000-1999, and 2000+ steps in a row. These data were calculated as a percentage of total locomotor bouts each day and as a percentage of total steps each day.

## RESULTS and DISCUSSION

An overwhelming number of bouts were extremely short with more than 36% of all bouts just 2-9 steps in a row. More than 55% of all bouts lasted less than 20 steps in a row and bouts of 500-999 steps in a row were less than 1% of all walking bouts. This suggests that most walking covers very short distances before stopping, with stability and maneuverability of primary importance. The ability to initiate gait,

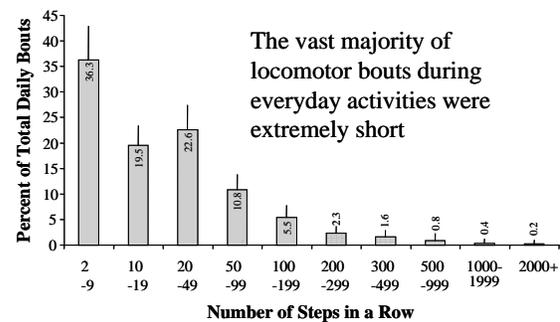


Figure 1. Locomotor bout length plotted as a percent of total daily bouts.

accelerate to the desired speed, maneuver around obstacles, decelerate and terminate gait is the most fundamental locomotor behavior. It is this type of walking that allows participation in daily activities with peers, and this should be the primary

walking goal for children with gait pathology. Once short duration walking is accomplished, longer duration bouts should be the secondary goal to acquire the full capacity to engage in all activities.

Although many extremely short walking bouts were observed in typically developing children, these did not account for a large percentage of total daily steps: Only 10.1% of total daily steps occurred in bouts of less than 20 steps in a row. About 45% of all steps were taken in bouts of 20-200 steps in a row. Bouts of less than 300 steps in a row accounted for more than 65% of total daily steps. Bouts of 2000+ steps in a row were rare occurrences, but accounted for about 6% of all steps taken each day. These long duration bouts occurred approximately once every four days suggesting a natural work-recovery cycle.

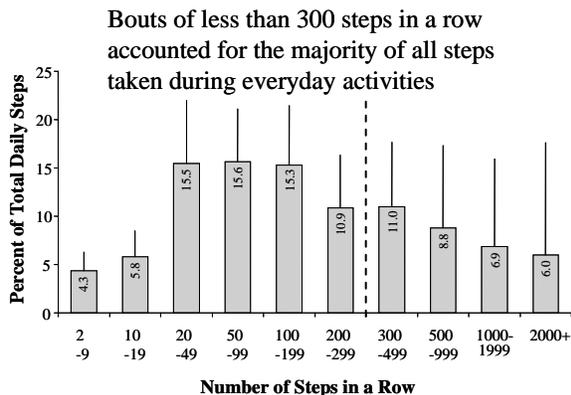


Figure 2. Locomotor bout length plotted as a percent of total daily steps.

When grouped by age, the percent of steps taken in bouts of 2000+ steps in a row was highest in 11 year olds (9.8%), but was significantly lower for 12 year olds (6.0%) and the 13 year olds (4.6%;  $p < 0.02$ ). Total daily steps also followed this pattern, with most of the decrease in steps in these long duration bouts for 12 and 13 year old children. These data suggest that long-duration locomotor behavior that might have enough intensity to improve fitness



Figure 3. The percent of Total Daily Steps taken in bouts of 2000+ steps in a row across four age groups.

begins to decline in 12 and 13 year old children. The decrease may be the beginning of a sedentary lifestyle as children cease active play and do not engage in organized sports.

## SUMMARY AND CONCLUSIONS

The real-world locomotor demand for children consists of short bouts of walking containing a low number of total daily steps; moderate duration bouts that contain the majority of total daily steps; and very infrequent long duration bouts with a larger number of total daily steps that may stimulate a training response and ultimately reduce inactivity-related risk factors. This method characterizes the bout length distribution that defines the real-world mobility demands for typically developing children and adolescents. Methods to assess intensity have been published previously[2], and combining these methods could objectively characterize the intensity, duration, frequency and adherence of locomotor exercise programs.

## REFERENCES

- [1] Orendurff, M.S., et al (2008) *J Rehab Res Dev*, **45**, 1077-1090.
- [2] Orendurff, M.S., et al (2010) *J Strength Cond Res*, in press.