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Comparison of Step-Based Metrics Under Laboratory and Free-Living Conditions in Femoroacetabular Impingement Syndrome

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Context: Femoroacetabular impingement syndrome (FAIS) causes pain and functional limitations. Little is known regarding walking characteristics, volume, and intensity evaluated in laboratory and free-living conditions and whether these measures differ between those with FAIS and uninjured individuals.

Objective: To examine the differences in laboratory gait measures and free-living step-based metrics between individuals with FAIS and uninjured control participants.

Design: Comparative, cross-sectional study.

Patients or Other Participants: We enrolled 25 participants with FAIS and 14 uninjured controls.

Main Outcome Measure(s): We evaluated laboratory spatiotemporal gait measures (cadence, velocity, step length, stride length) during self-selected and fast walking speeds using an instrumented walkway. Participants then wore an accelerometer around the waist during waking hours for 7 consecutive days. Free-living step-based metrics included average daily steps, peak 1- and 30-minute cadence, and average daily time spent in walking cadence bands. We compared laboratory gait measures and step-based metrics between groups.

Results: The groups did not differ in laboratory spatiotemporal gait measures during both speeds (all $P > .05$). The FAIS group took fewer daily steps (5346 ± 2141 versus 7338 ± 2787 steps/d; $P = .030$) and had lower peak 1-minute (92.9 ± 23.9 versus 119.6 ± 16.3 steps/min; $P < .001$) and 30-minute cadences (60.9 ± 27.1 versus 86.8 ± 22.4 steps/min; $P = .003$) compared with uninjured controls, respectively. The FAIS group also spent less time in slow (6.0 ± 3.6 versus 10.3 ± 3.4 min/d; $P = .001$), medium (4.5 ± 4.2 versus 8.9 ± 4.4 min/d; $P = .005$), and brisk/moderate (4.5 ± 6.2 versus 12.2 ± 10.3; $P = .020$) cadence bands compared with uninjured controls.

Conclusions: Clinical/laboratory gait measures alone may not be representative of real-world walking-related physical activity behavior in individuals with FAIS.

Key Words: cadence, physical activity, FAIS, hip morphology

Key Points

- Individuals with femoroacetabular impingement syndrome took fewer daily steps, had a lower peak 1-minute and 30-minute walking cadence, and spent less time in faster rates of walking-related movement compared with controls.
- Clinical/laboratory gait measures alone may not be representative of real-world walking-related physical activity behavior in individuals with femoroacetabular impingement syndrome or in other musculoskeletal pain conditions.

Femoroacetabular impingement syndrome (FAIS) is a prearthritic hip disorder characterized by bony morphology of the femoral head/neck (*cam type*), the acetabulum (*pincer type*), or in some cases, both (*mixed type*).[1] This abnormal overgrowth of bone may lead to unbalanced force distribution in the hip joint that is thought to cause intra-articular injuries to the labrum and cartilage.[2–6] Individuals with FAIS often report hip pain, limited hip-related function, and poor quality of life, and are at risk for developing early-onset hip osteoarthritis over time.[1,7–14] Importantly, regarding free-living function and activity, recent authors have reported that individuals with FAIS were less active than their peers and walked at slower speeds during laboratory-measured gait testing compared with healthy individuals.[10,11,15–17]

Across various patient populations, slow walking speed has been associated with disability, mortality, and other comorbidities (eg, heart disease).[18,19] Cadence, or the number of steps an individual takes per minute, is a simple measure of gait

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function and physical activity (PA) that has wide appeal for researchers, clinicians, and the public.[20–22] Cadence can be measured using overground devices (eg, gait mats) in controlled (laboratory) environments or using wearable technologies (eg, fitness trackers and accelerometers) in uncontrolled (free-living) environments and provides a unique approach for determining an individual's PA and walking-related intensity.[23] Currently, little is known regarding walking characteristics, volume, and intensity evaluated in both laboratory and free-living conditions and whether these measures differ between those with FAIS and uninjured individuals. We are aware of only 1 study whose authors evaluated minute by minute time spent at varying stride frequencies (ie, percentage of time spent in no activity, low activity, medium activity, and high activity) between individuals with FAIS and healthy control participants.[15] Those authors reported no differences in the percentage of time spent across stride frequencies between individuals with FAIS and healthy controls.[15] Further investigation is required to more comprehensively assess walking-related behavior using pragmatic approaches in a manner that considers both volume (eg, steps per day) and stepping pattern/intensity (eg, step-based metrics) under free-living conditions. Such findings could provide insight into how daily walking behavior is affected in those with FAIS, potentially providing critical markers of disease progression, recovery after treatment, and/or long-term joint health in this population. Additionally, clinical interventions could be developed to target free-living PA and walking behavior most affected in those with FAIS.

In this study, we compared laboratory gait measures (cadence, gait velocity, step length, and stride length) and free-living step-based metrics (daily steps, peak 1-minute and 30-minute cadences, in addition time spent in cadence bands) between individuals with FAIS and uninjured controls. We hypothesized that individuals with FAIS would demonstrate reduced spatiotemporal gait outcomes during laboratory-measured gait testing, take fewer daily steps, demonstrate lower peak 1-minute and 30-minute walking cadences, and spend less time at higher paced/intensity walking than uninjured control participants.

METHODS

Participants

We enrolled 2 groups: individuals with FAIS and uninjured control participants. Individuals with a diagnosis of FAIS were recruited from the practice of 3 clinical collaborators (A.M.M. at the Department of Orthopaedic Surgery, University of Alabama at Birmingham; B.A.E. and M.K.R. at Andrews Sports Medicine and Orthopaedic Center, Birmingham, AL). Diagnosis of FAIS followed the Warwick Agreement (2016) consensus recommendations, including a combination of the following diagnostic criteria: (1) radiographic signs of impingement-related bony morphology (eg, cam, pincer, or mixed), (2) positive clinical findings (eg, painful hip range of motion or positive intra-articular provocation tests), and (3) reporting associated symptoms (groin/hip pain or stiffness).[1] We enrolled uninjured control participants who reported no history of groin/hip pain, major lower extremity injury/surgery (we included those with 2 or fewer lateral ankle sprains), or spine surgery from the local community via flyers and word of mouth. We performed a screening phone call with potential participants before enrollment, and we excluded both individuals with FAIS and potential control participants if they reported that they had been diagnosed with hip osteoarthritis or with osteopenia/osteoporosis, or if currently pregnant. Before enrolling in the study, we required all participants (FAIS and controls) to be actively engaged in a purposeful activity greater than 50 h/y (or to have been before the onset of hip/groin pain for those with FAIS).[24–26] We obtained institutional review board approval for the study before initiation (IRB 300001355), and all participants provided written informed consent before participating.

Laboratory Assessments and Prior Activity Levels

Standard demographic and anthropometric data were collected, including age, sex, and body mass index (BMI). Physical activity levels before enrolling in our study were evaluated in the FAIS and uninjured control participants using the International Physical Activity Questionnaire short form (IPAQ).[27] The IPAQ is a valid, reliable, and widely used tool for evaluating self-reported activity in the previous 7 days.[27] We measured spatiotemporal gait parameters in all participants using a GAITRite Platinum Plus Classic walkway (GAITRite). The GAITRite is a portable pressure-sensitive electronic walkway used to evaluate gait, and provides fast, clinically relevant measures to identify gait abnormalities.[28] It has been used across various patient populations, including in studies of those with total hip arthroplasty.[29] We assessed cadence (steps per minute), gait velocity (meters per second), step length (centimeters), and stride length (centimeters) in all participants, during both a self-selected preferred and fastest (maximum) walking speed (2 trials at each speed). For the self-selected trials, we instructed participants to walk at a speed that they would use to purposefully go from one place to another. For the fastest walking speed, we instructed participants to walk as fast as possible without jogging or running. We used the software associated with the GAITRite to calculate average values (involved and uninvolved limbs for FAIS; right and left limbs for controls) over the 2 trials at both speeds for the aforementioned variables.

Free-Living Step-Based Metrics Assessment

After the laboratory visit, we provided all participants a waist-worn accelerometer (ActiGraph GT3X+) to wear for 7 consecutive days on an elastic belt (above the nonpainful hip for the FAIS group; above the nondominant hip for the control group).[10,11] We instructed participants to wear the accelerometer from when they awoke in the morning throughout the entire day, and to take it off only when sleeping or during water-based activities such as swimming or showering. We provided participants a daily log sheet to record the time they put the accelerometer on, the time they took it off, and any time during the day that the accelerometer was not worn. Accelerometers were initialized to collect continuous data at 100 Hz and summarized in 1-minute epochs.[30] We downloaded and processed the accelerometry data using the Troiano wear-time algorithm and ActiGraph's proprietary step algorithm in the ActiLife software (version 6.13.3).[31] The final dataset included data from participants with valid wear time ($\geq$8 hours of daily wear time for $\geq$4 valid days).[32]

Accelerometry data were further processed using a custom function in R (step_metrics; https://github.com/jhmigueles/step_metrics) to produce 3 step-based metrics: (1) daily step

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Table 1. Characteristics of the Sample at the Testing Visit[a]

	FAIS Group (n = 25)	Control Group (n = 14)	*P* Value
Age, mean ± SD (range), y	31.0 ± 9.2 (18.8–46.0)	28.1 ± 9.1 (20.4–50.4)	.341
Sex, No. (%)			
Female	15 (60)	9 (64)	.792
Male	10 (40)	5 (36)	
Height, mean ± SD, cm	173.0 ± 13.1	170.2 ± 6.8	.394
Weight, mean ± SD, kg	78.7 ± 21.7	76.1 ± 10.6	.624
Body mass index, mean ± SD, kg/m^2	26.1 ± 4.7	26.3 ± 3.4	.899
Accelerometer wear time, mean ± SD, min/d	824.3 ± 71.5	836.7 ± 57.3	.581
FAIS subtype, No. (%)			
Cam	13 (52)	NA	NA
Pincer	4 (16)		
Combined	8 (32)		
Symptom duration, mean ± SD, y	4.7 ± 7.1	NA	NA
IPAQ scores, mean ± SD			
Average time spent in vigorous activity, min	38.8 ± 61.4	34.1 ± 25.0	.747
Average time spent in moderate activity, min	43.9 ± 85.0	16.4 ± 16.3	.112
Average time spent in walking, min	147.2 ± 172.0	67.9 ± 113.8	.067

Abbreviations: FAIS, femoroacetabular impingement syndrome; IPAQ, International Physical Activity Questionnaire; NA, not applicable.
[a] *P* values are from independent 2-sample *t* tests for continuous data or Pearson χ^2 tests for categorical data.

counts (steps per day), (2) peak 1-minute cadence (steps per minute), and (3) peak 30-minute cadence (steps per minute). Peak 1-minute cadence summarizes an individual's highest minute of walking (best effort/pace in term of steps per minute) within a day, averaged across all valid wear days. Peak 1-minute cadence values can be interpreted as an indicator of both functional capacity and behavioral decision to walk at higher/faster rates of movement.[33–35] Peak 30-minute cadence summarizes the highest 30 minutes (not necessarily consecutive) of activity within a day, averaged across all valid wear days. Peak 30-minute cadence reflects both the intensity and persistence of stepping behavior performed by individuals within and across days.[34,36–38] Additionally, the step-metrics function calculates time spent (minutes) within cadence bands, including nonmovement (zero cadence), incidental movement (1–19 steps/min), sporadic movement (20–39 steps/min), purposeful movement (40–59 steps/min), slow walking (60–79 steps/min), medium walking (80–99 steps/min), brisk/moderate walking (100–119 steps/min), and faster walking (≥120 steps/min),[39,40] averaged across valid days.

Statistical Analyses

We compared demographic and anthropometric characteristics, IPAQ scores, laboratory spatiotemporal gait assessment (cadence, velocity, step length, stride length), step-based metrics (daily steps, peak 1-minute and 30-minute walking cadence), and time spent in various cadence bands between the FAIS and control groups using independent-samples *t* tests (assumptions for *t* tests were met). Cohen d effect sizes were calculated and interpreted as 0.2 = *small*, 0.5 = *medium*, and 0.8 = *large*.[41] We used the Statistical Package for the Social Sciences (V.27, SPSS) for all statistical analyses, and a significance level was set a priori ($\alpha < .05$).

RESULTS

Demographic and anthropometric data for the groups are shown in Table 1. There were no significant differences in age, sex distribution, BMI, IPAQ scores, or accelerometer wear time between FAIS and uninjured control participants (Table 1; all $P > .05$). Descriptive data for gait cadence, velocity, step length, and stride length during self-selected and fast walking speeds are shown for the groups in Table 2. Although the laboratory gait-related variables were not statistically different (all $P > .05$), we did observe small to medium effect sizes (d = 0.2–0.7). In particular, the FAIS group displayed lower cadence values during both the preferred and fast walking trials compared with controls.

There were significant differences in daily steps, peak 1-minute cadence, and 30-minute cadence between individuals with FAIS and uninjured control participants, with lower

Table 2. Comparisons of Laboratory Gait Parameters During Self-Selected and Fast Walking Speeds[a]

	FAIS Group (n = 20)	Control Group (n = 12)	*P* Value	Effect Size (Cohen d)
Self-selected speed				
Cadence, steps/min	113.6 ± 18.4	124.8 ± 15.5	.077	0.7
Velocity, m/s	1.5 ± 0.5	1.6 ± 0.4	.402	0.3
Step length, cm	76.3 ± 11.9	76.9 ± 9.9	.878	0.1
Stride length, cm	152.8 ± 24.0	154.3 ± 19.7	.858	0.1
Fast-walking speed				
Cadence, steps/min	131.2 ± 17.5	138.8 ± 16.9	.239	0.4
Velocity, m/s	1.9 ± 0.4	2.0 ± 0.41	.625	0.2
Step length, cm	86.5 ± 10.9	84.5 ± 10.2	.594	0.2
Stride length, cm	173.7 ± 21.9	169.4 ± 20.5	.582	0.2

Abbreviation: FAIS, femoroacetabular impingement syndrome.
[a] All data are reported as mean ± SD. *P* values were obtained using independent 2-sample *t* tests.

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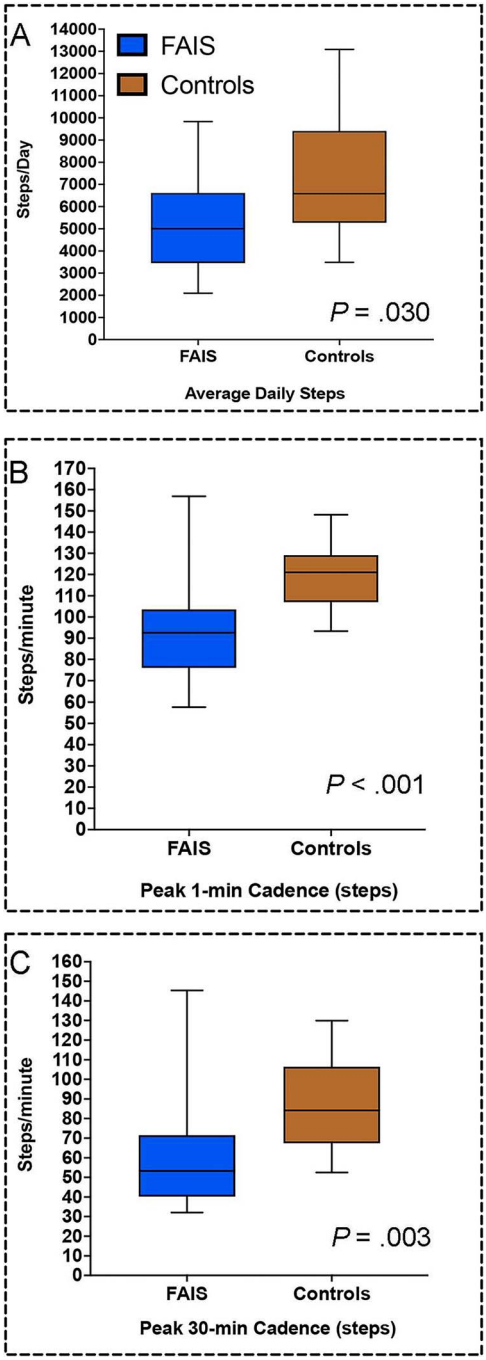

Figure 1. Group comparisons of A, daily steps, B, peak 1-minute cadence, and C, 30-minute cadence. Abbreviation: FAIS, femoroacetabular impingement syndrome.

values observed for the FAIS group (Figure 1A through C). Additionally, there were significant differences in average time (minutes) spent in slow walking, medium walking, and brisk/moderate walking between individuals with FAIS and uninjured control participants, with lower values observed for the FAIS group (Figure 2E through G). No other significant group differences were found in the remaining cadence bands (all P values $>$ .05; Figure 2A through D and H). Descriptive data for daily steps, peak 1-minute and 30-minute cadence, and time spent in each cadence band for both groups are presented in Table 3.

DISCUSSION

Our main findings indicated that individuals with FAIS had significantly lower average daily steps and peak 1-minute and 30-minute walking cadence and spent fewer minutes in slow, medium, and brisk walking paces/intensities compared with uninjured controls. In contrast, laboratory-measured spatiotemporal parameters during self-selected and fast walking speeds were not statistically different.

We hypothesized that there would be differences in spatiotemporal gait measures when comparing groups due to hip pain, limited hip range of motion, and/or patient-reported symptoms that are commonly associated with FAIS.[1] The FAIS group displayed a lower cadence during the preferred ($P = .077$, d = 0.7; Table 2) and fast walking trials ($P = .239$, d = 0.4; Table 2). However, these differences were not statistically significant despite small to moderate between-groups effect sizes. Authors of 2 previous studies have evaluated laboratory-measured gait speed, cadence, step length, and stride length in those with FAIS and uninjured control participants.[17,42] The first study reported that controls demonstrated significantly higher gait speed and cadence compared with FAIS individuals.[17] Notably, they reported gait parameters for the painful/involved limb within the FAIS group, whereas we report gait parameters based on the average value for involved and uninvolved limbs.[17] The second study reported no significant differences in laboratory gait measures between those with FAIS and controls, consistent with our laboratory gait-related findings.[42] In our study, we used a GaitRite walking mat to evaluate our laboratory gait measures, whereas both of the other previous studies used a 3-dimensional motion-capture system to evaluate laboratory gait measures.[17,42] Differences in the accuracy of the measurement approach and the calculation of the specific laboratory gait-related measures might explain, at least in part, the differences between our findings and those of previous studies.

When comparing free-living PA using step-based metrics, we observed significant differences in volume and peak metrics between the groups (Figures 1 and 2; see Table 3 for detailed descriptive data). Specifically, average daily steps and peak 1-minute and peak 30-minute cadences were all higher in the healthy control group as compared with the FAIS group. Our findings regarding comparison of daily steps between individuals with FAIS and healthy controls were different from those of 2 previously published studies.[11,15] Whereas prior researchers found that those with FAIS demonstrated lower device-measured PA (general activity measured by volume and intensity), authors of 2 prior studies specifically evaluating step counts reported no significant difference between those with FAIS and healthy controls.[10,11,15,16] Regarding time spent in various cadence bands, uninjured controls and FAIS did not differ in time spent in nonmovement, incidental movement, sporadic movement, or purposeful walking. Notably, however, the uninjured control group spent more time in slow walking, medium walking, and brisk walking compared with the FAIS group. This is in contrast to a previous study (n = 74) that reported no significant differences in the percentage of time spent in various stride frequency bands in those with FAIS compared with healthy control participants.[15]

Several methodological aspects could explain the inconsistencies between our findings and previously published work

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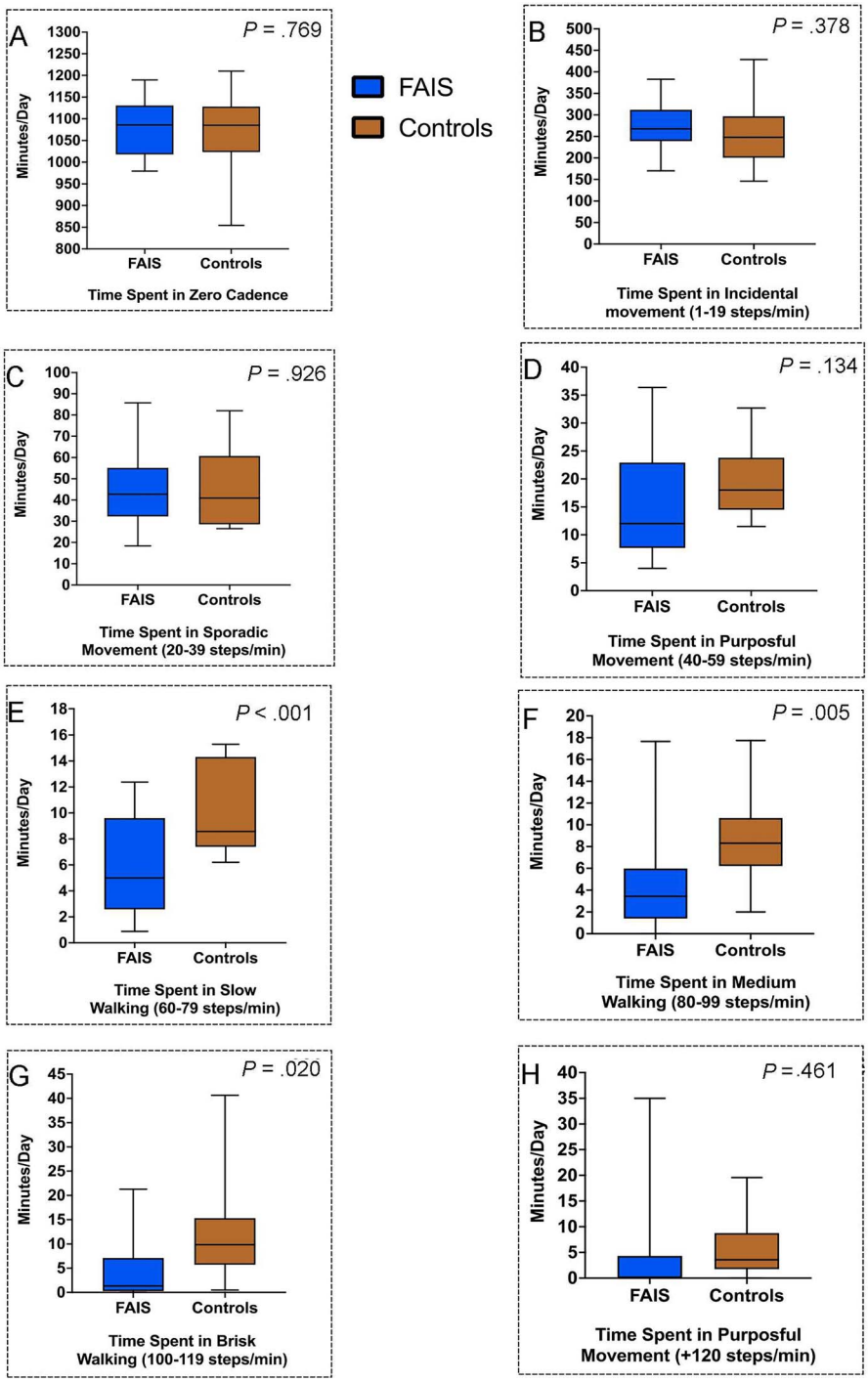

Figure 2. Group comparisons of average time spent in cadence bands. A, Time spent in zero cadence. B, Time spent in incidental movement (1–19 steps/min). C, Time spent in sporadic movement (20–39 steps/min). D, Time spent in purposeful movement (40–59 steps/min). E, Time spent in slow walking (60–79 steps/min). F, Time spent in medium walking (80–99 steps/min). G, Time spent in brisk walking (100–119 steps/min). H, Time spent in faster movement (+120 steps/min). Abbreviation: FAIS, femoroacetabular impingement syndrome.

regarding walking-related activity measures in those with FAIS in comparison with uninjured control participants. In our study, we recorded daily activity using an accelerometer over 7 days, including weekdays and weekends, when activity patterns might be different.[43] Additionally, we used a waist-worn accelerometer placement, which is more convenient for the participant and associated with better wear-time compliance.[44] Previous studies used different methods to quantify activity.[11,15] For example, authors of one study recorded daily activity over only 5 days and used a thigh-worn accelerometer, and did not specify whether weekday and/or weekend days were included.[11] Widely accepted best practice is to measure PA over 7 days to capture sufficient variability in estimating average daily activity, and the average valid wear days were 6.2 and 6.6 days for the FAIS and control groups, respectively, in our cohort.[45,46] The other study that recorded daily activity for a 7-day period used a step watch, an ankle-worn device.[15] Previous studies have reported differences between step-count

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Table 3. Comparison of Step-Based Metrics and Time Spent Within Different Cadence Bands Between FAIS and Uninjured Controls[a]

Outcome	FAIS (n = 25)	Uninjured Controls (n = 14)	*P* Value	Effect Size (Cohen d)
Average wear valid days, d	6.2 ± 1.0	6.6 ± 0.7	.170	0.4
Daily steps	5346 ± 2141	7338 ± 2787	.030[b]	0.8
Peak 1-minute cadence, steps/min	92.9 ± 23.9	119.6 ± 16.3	<.001[b]	1.3
Peak 30-minute cadence, steps/min	60.9 ± 27.1	86.8 ± 22.4	.003[b]	1.0
Time spent in nonmovement (zero cadence/min), min/d	1079.0 ± 59.8	1070.5 ± 97.3	.769	0.1
Time spent in incidental movement (1–19 steps/min), min/d	273.7 ± 50.7	253.6 ± 74.4	.378	0.3
Time spent in sporadic movement (20–39 steps/min), min/d	45.4 ± 19.9	46.0 ± 18.9	.926	0.03
Time spent in purposeful movement (40–59 steps/min), min/d	15.6 ± 9.6	19.6 ± 6.5	.134	0.5
Time spent in slow walking (60–79 steps/min), min/d	6.0 ± 3.6	10.3 ± 3.4	<.001[b]	1.2
Time spent in medium walking (80–99 steps/min), min/d	4.5 ± 4.2	8.9 ± 4.4	.005[b]	1.0
Time spent in brisk/moderate walking (100–119 steps/min), min/d	4.5 ± 6.2	12.2 ± 10.3	.020[b]	0.9
Time spent in faster walking (120+ steps/min), min/d	4.0 ± 8.5	5.7 ± 5.9	.461	0.2

Abbreviation: FAIS, femoroacetabular impingement syndrome.
[a] Data are reported as mean ± SD. *P* values were obtained using independent 2-sample *t* tests.
[b] Denotes significant difference between groups ($P < .05$).

estimates for the ankle-worn, thigh-worn, and waist-worn devices based on proximity to the foot.[47] In our study, we included participants (FAIS and controls) with similar demographic and anthropometric data (no significant differences between groups); however, both of the previously published studies included participants (FAIS and controls) with varying ranges of age, sex, and BMI (the FAIS groups were significantly different in demographic data in comparison with controls).[11,15] To that end, our results may have greater external validity, as the differences we observed in clinical and free-living gait parameters/PA between groups are less likely to be attributed to differences in demographic and anthropometric characteristics (no significant differences in demographic/anthropometric data between FAIS and controls) and more likely to be attributed to FAIS symptomology.

With respect to the pattern of PA accumulation (ie, cadence bands), the control group spent approximately double the amount of time in slow and medium walking and triple the amount of time in brisk walking intensities compared with the FAIS group, with an observed large effect size between the groups (Table 3). However, the groups did not differ in the accumulation of time in the lowest-intensity cadence bands (ie, nonmovement, incidental movement, sporadic movement, and purposeful movement; Table 3). Overall, this may suggest that both groups spent similar time at the lowest walking intensity levels but spent differing amounts of time at higher intensities and faster rates of walking. The comparison of time spent in these cadence bands suggests that individuals with FAIS either lacked the capacity to walk at higher rates of movement or chose to limit the amount of time spent at a faster rate of movement. Clinicians working with individuals with FAIS may consider using wearable devices to evaluate walking behavior in real-world settings that would enable them to better understand the impact of FAIS and the effectiveness of rehabilitation or medical interventions, and/or to develop or target behavioral interventions specific to free-living walking behavior in this patient population.

Our study has several strengths and limitations that should be considered when evaluating our findings. It is the first study to comprehensively examine step-based metrics including peak cadence and time spent at various cadence bands during free-living conditions between individuals with FAIS and demographically similar uninjured control participants. Although our sample size was small, our comparative study design allowed us to evaluate differences between groups with similar demographic and anthropometric characteristics. A limitation of our study is that we processed our FAIS accelerometry data using cut points developed from healthy individuals, which might underestimate intensity of activity in those with FAIS due to natural differences in energetic cost of movement between those with FAIS and healthy controls. There is a need for further research to develop FAIS-specific accelerometry cut points to accurately define activity intensity in those with FAIS. Furthermore, we could not assume causality due to the cross-sectional design, and there may be bidirectional and reverse causality in play, meaning that we do not know if pain/functional limitations lead to lower activity/intensity or lower activity/intensity leads to pain/functional limitations. However, based on previous literature on patients with hip osteoarthritis, we know that hip-related pain and decreased function are often associated with low levels of activity.[48] Further, free-living PA, quantified herein using step-based metrics, may include nonstep movement artifact. It is impossible to quantify the exact amount of measurement error related to this issue during free-living observation; however, we note that we collected and processed the accelerometer data per the manufacturer's recommendations and in general alignment with numerous other studies.[46] Minute-level step data were computed and exported using ActiGraph's step algorithm, which has been validated in both laboratory controlled and free-living settings and is widely reported in the literature, including in national health surveillance studies such as the National Health and Nutrition Examination Survey (https://wwwn.cdc.gov/nchs/nhanes/2005-2006/PAXRAW_D.htm).[49–51] In the current study, we did not collect or control for pain scores in those with FAIS. Thus, it is possible that higher or lower pain intensity at the time of testing could have influenced functional performance and walking-related measures (previous researchers have shown that higher pain is often associated with lower activity).[48] Lastly, due to our small sample size, some of our group comparisons may have been underpowered to detect relevant differences, particularly in laboratory-measured cadence values, which did not statistically differ between groups but demonstrated small to moderate effect sizes.

Future studies are needed to comprehensively evaluate PA metrics that reflect the volume (steps/day) and peak effort/intensity (peak 1-minute and 30-minute cadences) of ambulatory

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activity, as well as time spent at various cadence bands that reflect a range of movement from nonmovement to faster rates of locomotion, in larger samples of individuals with FAIS. Additionally, there is a need for researchers to develop and validate disease-specific cut points for quantifying PA intensity in patients with FAIS. As opposed to just testing walking-related measures in clinical settings, clinicians should be encouraged to collect free-living PA data to examine effects of the clinical success of surgery alongside patient-reported outcomes in individuals with FAIS.

CONCLUSIONS

Individuals with FAIS took fewer daily steps, had lower peak 1-minute and 30-minute walking cadences, and spent less time in faster rates of walking-related movement compared with uninjured control participants. Overall, clinical gait-related measures were generally similar between those with FAIS and uninjured controls when measured during laboratory testing, but those with FAIS demonstrated lower walking-related peak effort/intensity during free-living measurement. Our findings support the use of wearable devices in patients with FAIS to examine how FAIS affects ambulation during free-living activity, and may be useful in identifying deficits in gait parameters and step-based PA metrics that could be targeted through rehabilitation and/or behavioral interventions in this patient population.

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