

# MOSAIC: Monitoring of Scratch via Accelerometry in Children with Atopic Dermatitis

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## Introduction

- Atopic Dermatitis (AD) is a common skin condition that affects **greater than 15% of adults** and **~20% of children** in high-income countries
- Global Burden of Disease Study (1990-2017): AD has the **highest disease burden among skin diseases** as measured by the disability-adjusted life-years
- AD is an “itch, [that leads to scratching](#), and ultimately results in rashes” creating a vicious cycle. Although itch and scratching are related - you can be itchy and not scratch and scratch and not be itchy!
- **Current Status:** Decisions are currently made based on **patient’s and caregiver questionnaires** that evaluate the feelings and experiences of the patient and **physician’s clinical assessments** of the rash (Clinical Outcome Assessment; COA)



Laughter MR, et al. The global burden of atopic dermatitis: lessons from the Global Burden of Disease Study 1990-1997. British Journal of Dermatology, 2020

**Hypothesis:** Using wrist-worn accelerometry devices and night-time scratch and sleep detection algorithms would provide passive and quantitative insight into Atopic Dermatitis in children, something that is not captured with current paradigms. However, we must fully understand the wearability, accuracy, sensitivity and specificity of the new digital endpoints being measured to be able to provide this insight.

# Methods, Demography and Screening

**Ages:** 2-11 years; N=41

**Inclusion criteria:** Diagnosed with Atopic Dermatitis and  $\geq 1$  on itch assessments (Observer Itch Assessment or Pruritus Assessment)

Endpoint	Clinical 	PRO 	Wearable Device 	Video 
Scratch			Nightly/Quantitative	Nights 1 and 2/Quantitative
Itch		Daily/Qualitative		
Sleep	PSG Night 2/Quantitative	Daily/Qualitative	Nightly/Quantitative	
Skin/Lesion	ISGA Screening and Day 5/Objective			

Demography/Screening Criteria		
Age	Mean (SD)	5.7 (2.90)
	Median (Min, Max)	5.0 (2, 11)
Gender	Female	23 (56.1%)
	Male	18 (43.9%)
BSA (Screening)	Mean (SD)	10.57% (7.15%)
	Median (Min, Max)	8.0 (5.0%, 39.5%)
ISGA (Screening)	Mean (SD)	2.6 (0.67)
	Median (Min, Max)	3 (2, 4)
Observer Itch Assessment (Screening) (Scale of 0-10) Age 2-5 years n=22	Mean (SD)	6.2 (2.05)
	Median (Min, Max)	6.0 (3, 10)
Pruritus Assessment (Screening) (Scale of 1-5) Age 6-11 years n=19	Mean (SD)	2.6 (0.90)
	Median (Min, Max)	2.0 (2, 5)

**BSA = Percent Body Surface Area; ISGA = Investigator's Static Global Assessment**

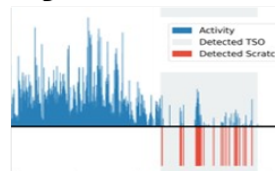


## Accelerometry



## Algorithms: ScratchPy and SleepPy

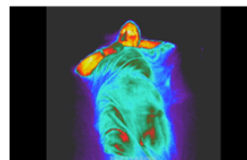
	Total Sleep Opportunity (min)	Total Sleep Time (min)	Percent Time Asleep (%)	Total Scratch Events (counts)	Total Scratch Duration (min)
Tuesday	414.0	300.0	72.46	249.0	32.65
Wednesday	551.0	469.0	85.12	197.0	28.65
Thursday	491.0	430.0	87.58	135.0	24.25
Friday	543.0	498.0	91.71	103.0	14.75



**vs.**

## “Gold” Standards ISGA PROs PSG (sleep)

## FLIR Video Annotation (Scratch)



Race/Ethnicity	
White	2 (4.9%)
Black/African America	22 (53.7%)
Multiracial	9 (22%)
Hispanic/Latino	5 (12.2%)
Other	3 (7.3%)

# Results

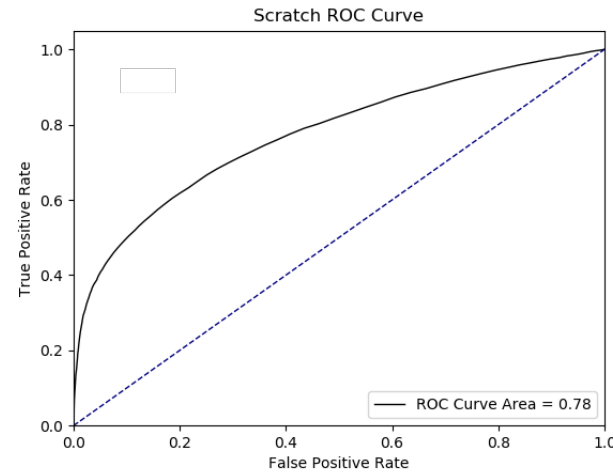
- Wearable sensors (accelerometry) plus algorithms can accurately, with high sensitivity and specificity, measure night-time scratch in children.

**Accuracy: 70.2%**

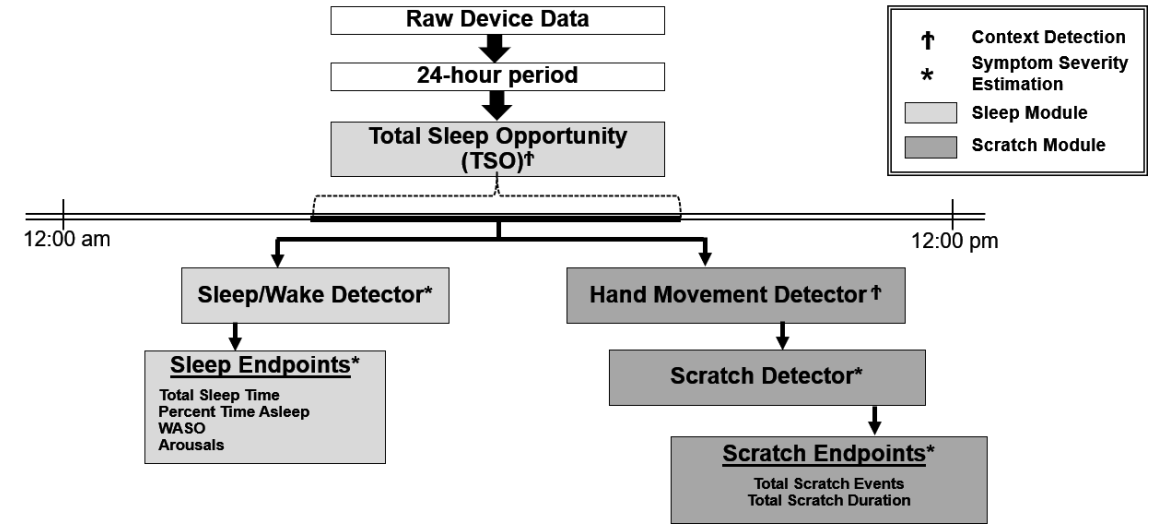
Video Annotation

		Scratching	No Scratching
		Scratching	No Scratching
ScratchPy	Scratching	13731 (80%)	3432 (20%)
	No Scratching	7647 (38%)	12352 (62%)

Sensitivity: 62%      Specificity: 80%



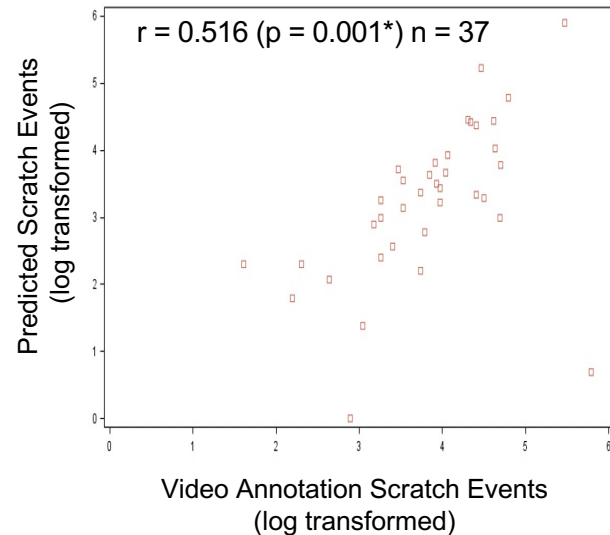
- Flowchart highlights the hierarchical approach for detection and assessment of sleep and night-time scratch using accelerometer data from a wrist-worn device.



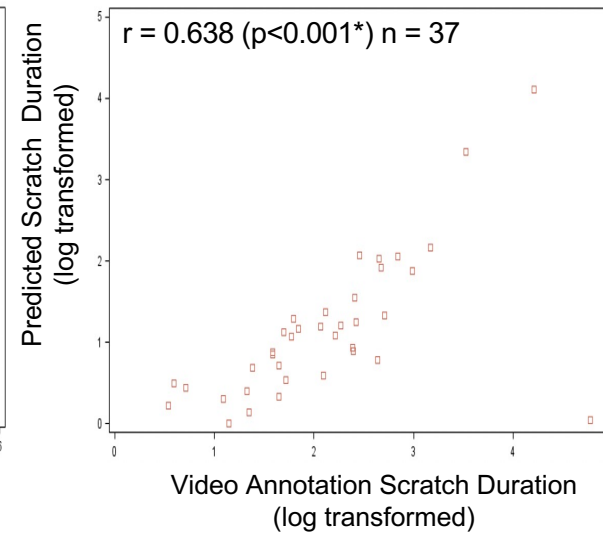
- Christakis Y, et al. Journal of Open Source Software. 2019;4:1663.
- Mahadevan, N, et al. Nature Digital Medicine, 2021

- The algorithm, ScratchPy, correlates with FLIR videography obtained scratch annotations.
- The algorithm, SleepPy, derived Total Sleep Time (TST) correlates with TST from PSG measures.

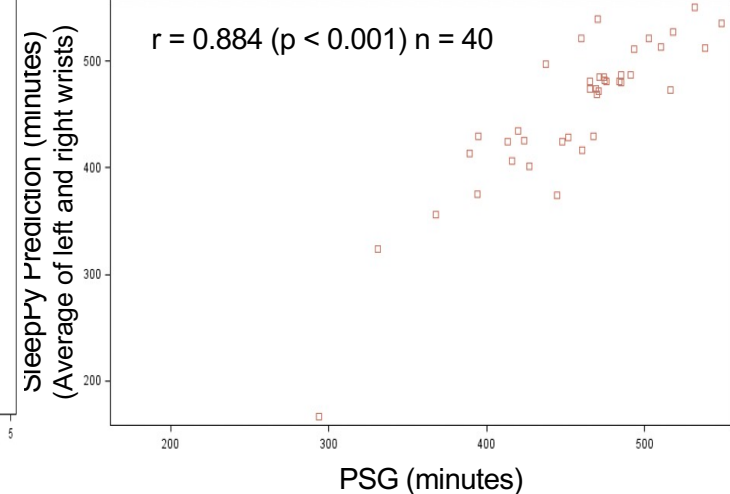
## Scratch Events



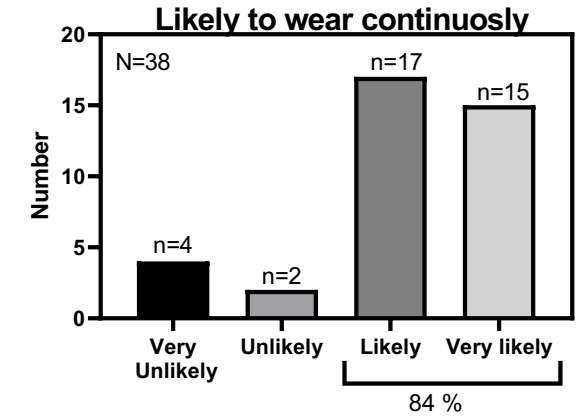
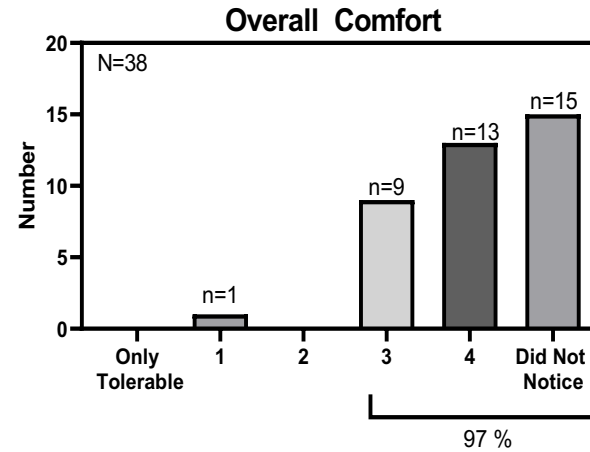
## Scratch Duration



## Total Sleep Time (Minutes) SleepPy vs PSG V02



- At the end of the study the participants/caregivers were asked if they found the devices comfortable and their likeliness to wear the devices continually.
- **Overall, a majority of the participants felt the devices were comfortable and would wear them continuously.**



## Summary:

- Night-time scratching and sleep quantity can be measured using digital wearable accelerometers and associated algorithms to provide endpoints with **high accuracy, specificity and sensitivity** in children with AD
- Moreover, night-time sleep and scratch algorithm assessments **correlate with “gold” standards**

## Conclusion:

Novel biosensors & digital technologies offer **incredible opportunities** in healthcare. The novel digital endpoints (NDE), night-time scratch and sleep, provide continuous, quantitative, accurate and objective measures in children with AD. Ultimately, these NDEs provide greater insight to key symptoms in children with AD; with the additional advantage of being able to be worn over time in a home environment, providing valuable understanding that can be used to improve diagnostics and treatment for this population.