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Smartphone data offer insights into disease activity and triggers in atopic dermatitis: a fully decentralised remote longitudinal pilot study

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Atopic Dermatitis, Environment, Weather, Pollen, Lifestyle, Digital

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LETTER TO THE EDITOR:

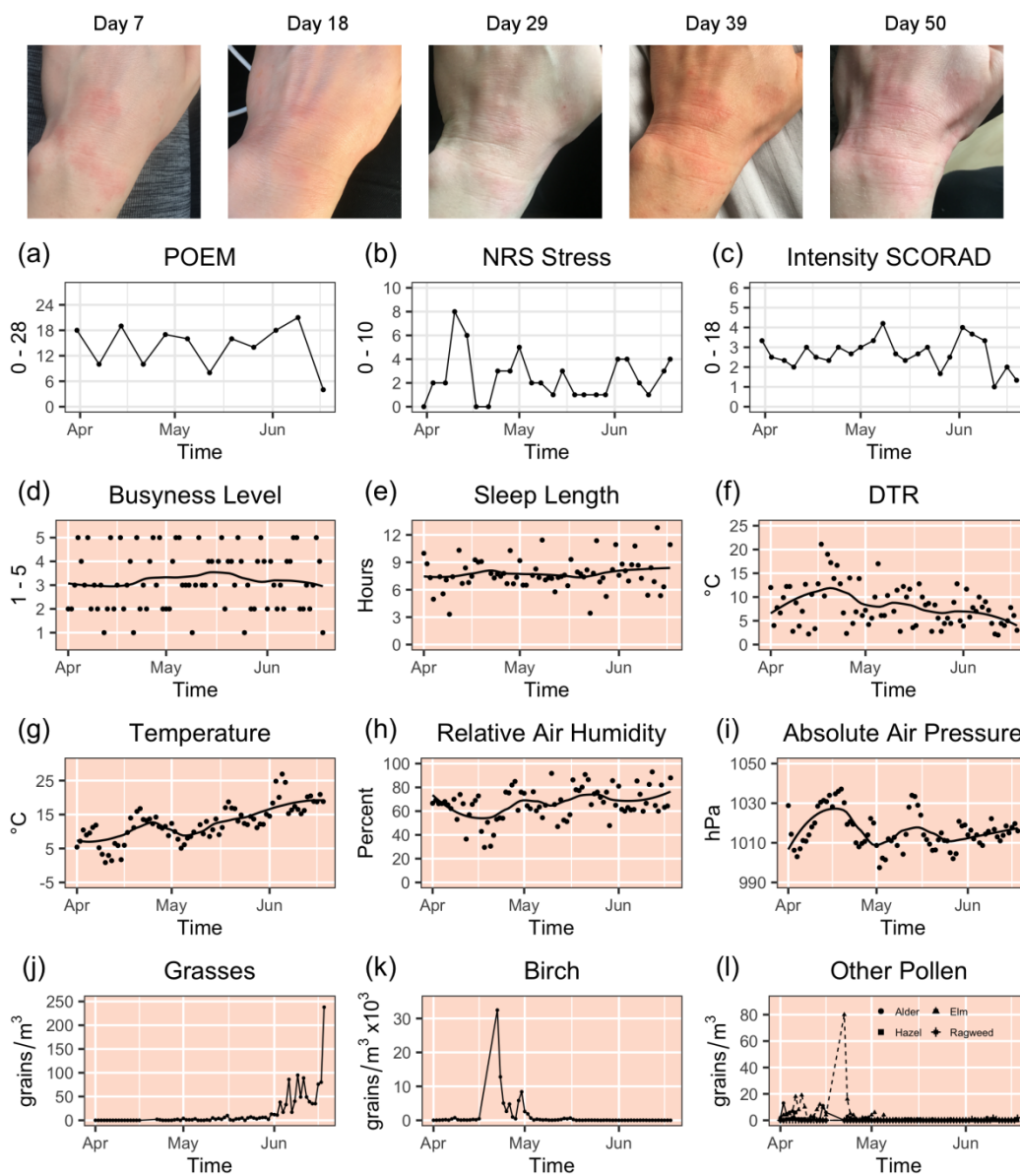
Atopic dermatitis (AD) is affected by both internal factors as psychological stress (1) and external factors as climate (2) and lifestyle (3). With the widespread adoption of smartphones, this offers a novel vehicle to collect data in real-time from a real-world setting. The aim of this study was to leverage mobile technology to conduct a fully remote longitudinal 12-weeks study in which a high-frequency sampling of both actively and passively collected data was used to explore disease and trigger associations within AD. 46 adults with AD according to UK diagnostic criteria (6) were recruited via social media as previously described (4). Twice weekly participants photographed 3 AD target lesions and answered online questionnaires (patient oriented eczema measure (POEM), and

numeric rating scale (NRS) stress) via their smartphone, while temperature, diurnal temperature range, absolute air pressure, relative air humidity and pollen data were received from online databases by extrapolation via the smartphone's GPS location. Sleep duration, daily active minutes and busyness levels were calculated from mobile sensor data via a downloaded smartphone application (www.theneura.com). Target lesions were scored by trained dermatologists as per the six intensity items of the SCORing Atopic Dermatitis (SCORAD) (5) and the mean daily iSCORAD was used for analysis as previously described (4). Linear mixed effect models, and non-parametric tests for seasonal data, were used to assess associations between disease severity and triggers. Data from 38 subjects, predominantly female (81.6%), average age of 33.1 (SD 9.9) years and average POEM of 12.0 (SD 5.9), were analysed as the rest had other diagnoses (n=4), dropped out (n=2) or data collection issues (n=2). Asthma was reported by 39.5%, and hay fever by 52.6%. Most subjects used moisturizers (92.1%) and topical medications (86.8%) for AD. Data from one subject is displayed in **figure 1**. A total of 885 questionnaires were completed (97%), and 2324 (83%) of the received photos allowed evaluation for disease severity. POEM was negatively associated with relative air humidity ($P=0.01$) and busyness level ($P=0.03$), and positively associated with stress ($P<0.001$) and air pressure ($P=0.05$). In addition, POEM was significantly higher in weeks with high Birch ($P=0.018$) and Elm pollen ($P=0.008$). Daily temperature tended to associate negatively with POEM while daily active time and diurnal temperature range showed no association with POEM. POEM was higher in weeks with shorter sleep duration, however not significant ($P=0.061$). Occasionally, the associations between triggers and POEM indicated opposite responses in the study population (**figure 2**). iSCORAD was positively associated with the self-reported stress levels ($P=0.002$) but not with any of the other passive data. iSCORAD was, however, strongly associated with POEM in a linear mixed effect model ($P<0.001$). Our findings are in line with previous studies reporting that low humidity decreases skin barrier function and, for most subjects, increases AD symptoms (6), that discrepancies exist with regards to temperature which may be both protective (3,6) and harmful (7), and that AD symptoms can be triggered by a variety of pollens (8,9). Furthermore, stress is a well-known trigger factor which this study also supports (10). Overall, our data indicates that within AD, the importance of specific trigger factors vary from patient to patient. In conclusion, data collected passively through the smartphone (mainly GPS) is associated with patients' subjective disease severity (POEM). This was shown for air humidity and -pressure, pollen and overall busyness level supporting that lifestyle and environmental factors are linked to AD disease activity.

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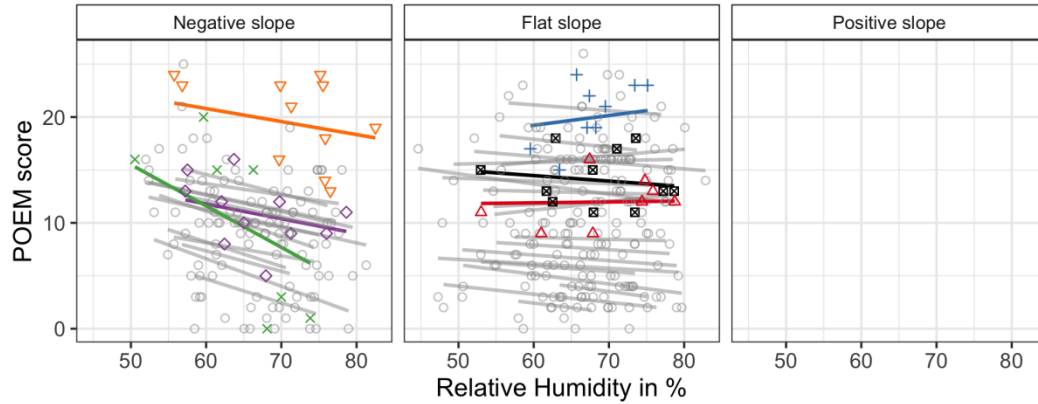
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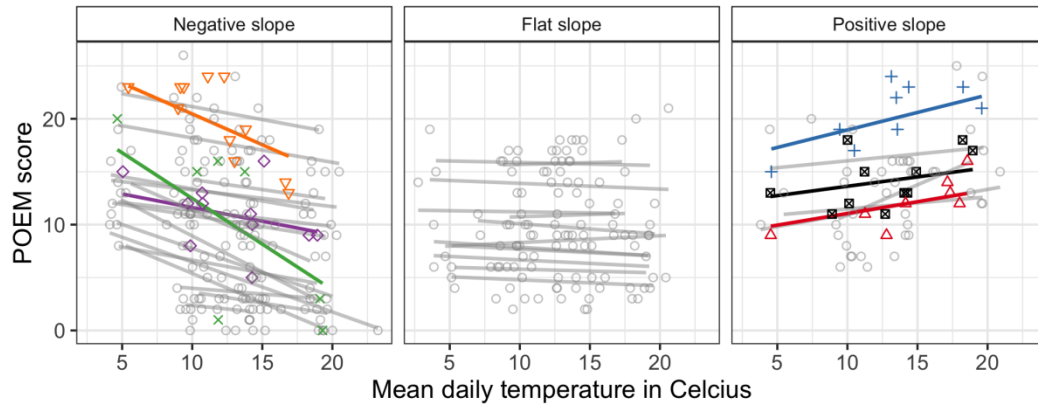


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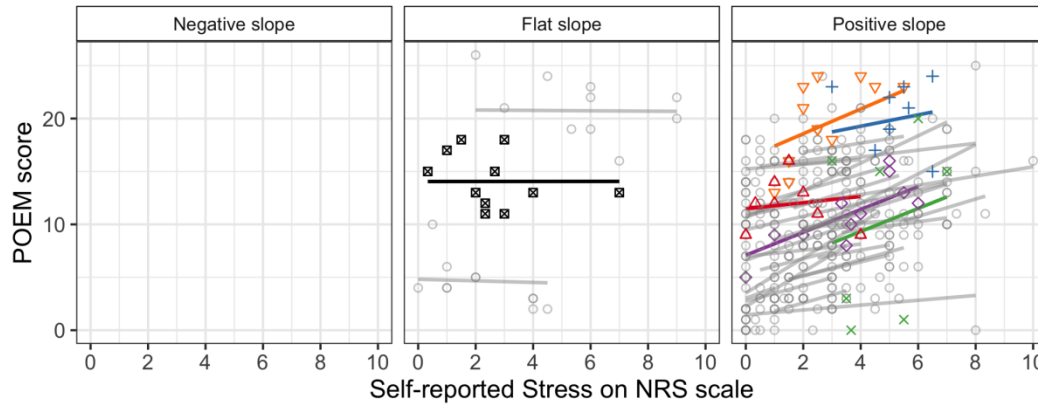
(a) Overall model significance: $p = 0.013$, fixed effect estimate = -0.10 , 95% CI: $[-0.17, -0.03]$



(b) Overall model significance: $p = 0.073$, fixed effect estimate: -0.14 , 95% CI: $[-0.28, -0.00]$



(c) Overall model significance: $p < 0.001$, fixed effect estimate: 0.67 , 95% CI $[0.37, 1.01]$



(d) Overall model significance: $p = 0.002$, fixed effect estimate: 0.08 , 95% CI: $[0.03, 0.13]$

