

Cloudy with a Chance of Pain:

A Smartphone-based Study of Weather, Disease Severity and Physical Activity in Patients with Rheumatoid Arthritis

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@CloudyPain



Smedslund and Hagen (2011): “Does rain really cause pain? A systematic review of the associations between weather factors and severity of pain in people with rheumatoid arthritis”

9 studies

Temperature, pressure, wind,
humidity (4 measures), sunshine, cloud
cover, thunderstorms, precipitation,
North-Atlantic Oscillation Index, solar radio
flux, sunspot count, ultraviolet radiation.

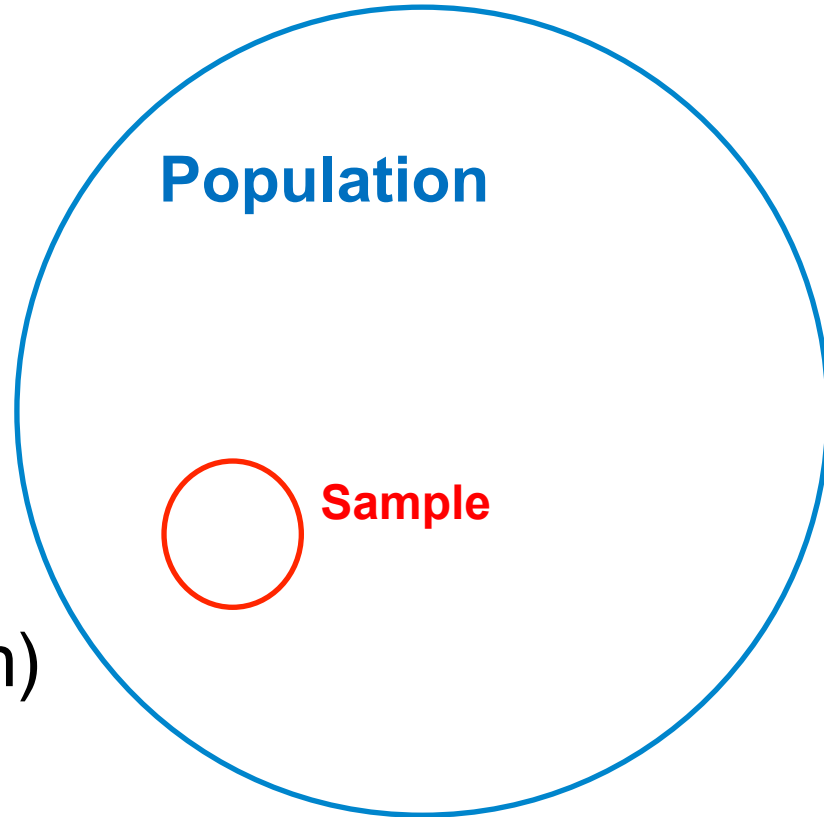
1. No consistent group effect of weather conditions on pain for people with rheumatoid arthritis.
2. Some patients may be more sensitive to weather-induced pain changes than others.

What limits previous studies?

Small sample sizes

16–92 patients

2 weeks to one year
(most less than a month)



What limits previous studies?

Not exposed to full-range of weather conditions

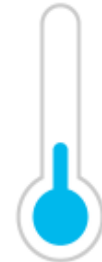
Patients were not exposed to outside weather conditions

Sample unrepresentative of average rheumatoid arthritis patient

What limits previous studies?

How weather data was handled

- Correlations, not causations
- Limited range of weather variables: absolute values, change, threshold, lag effect
- Weather/climate data not coincident with patient



What limits previous studies?

Lack of physical linkage between weather and pain



mobile Health (mHealth)

CLOUDY



WITH A CHANCE OF

P A I N

Disease severity
(app)

+

Weather (GPS)



Largest and longest
data collection effort
ever

Association between
weather and pain

Pain forecast

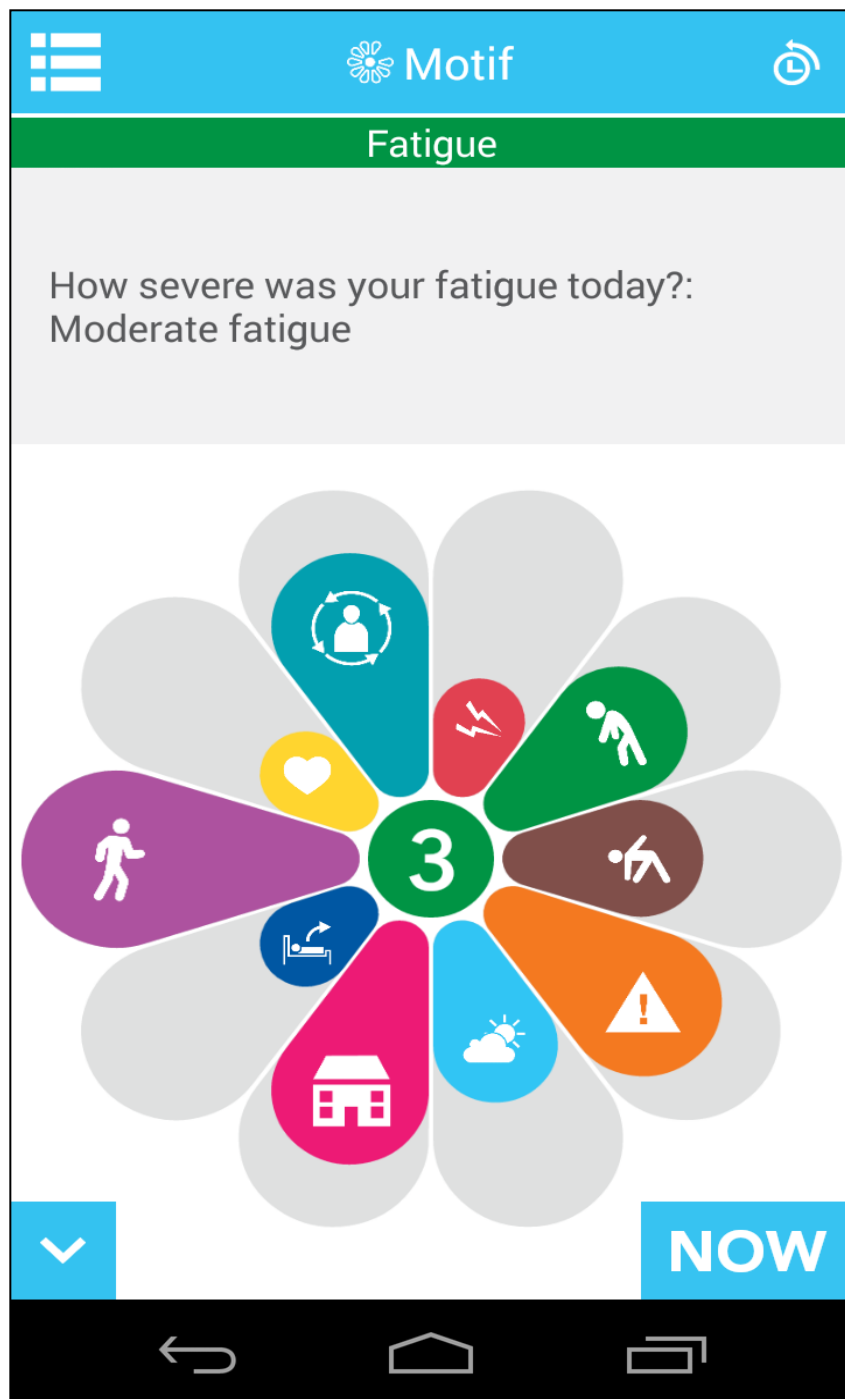
Pilot study, 2015



Co-design app with patients with rheumatoid arthritis

Interviews with patients to understand motivators and barriers to regular data entry

Pilot study of daily data entry over 2 months



Arthritis-specific items

1. Pain severity
2. Fatigue
3. Tiredness on waking
4. Morning stiffness
5. Wellbeing
6. Overall disease severity

Non arthritis-specific items

7. Mood
8. Physical activity
9. Time spent outside
10. Perceived influence of weather

Pilot study

Recruited 20 patients with rheumatoid arthritis

6 participants dropped out

Capture app problems (battery life, technical issues)
($n = 4$)

Health issues ($n = 2$)

Overall completion rate while in study: 68%

>5 entries per week 65% of the time

TWO

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Going behind the headlines to give you the definitive answers to our health questions.





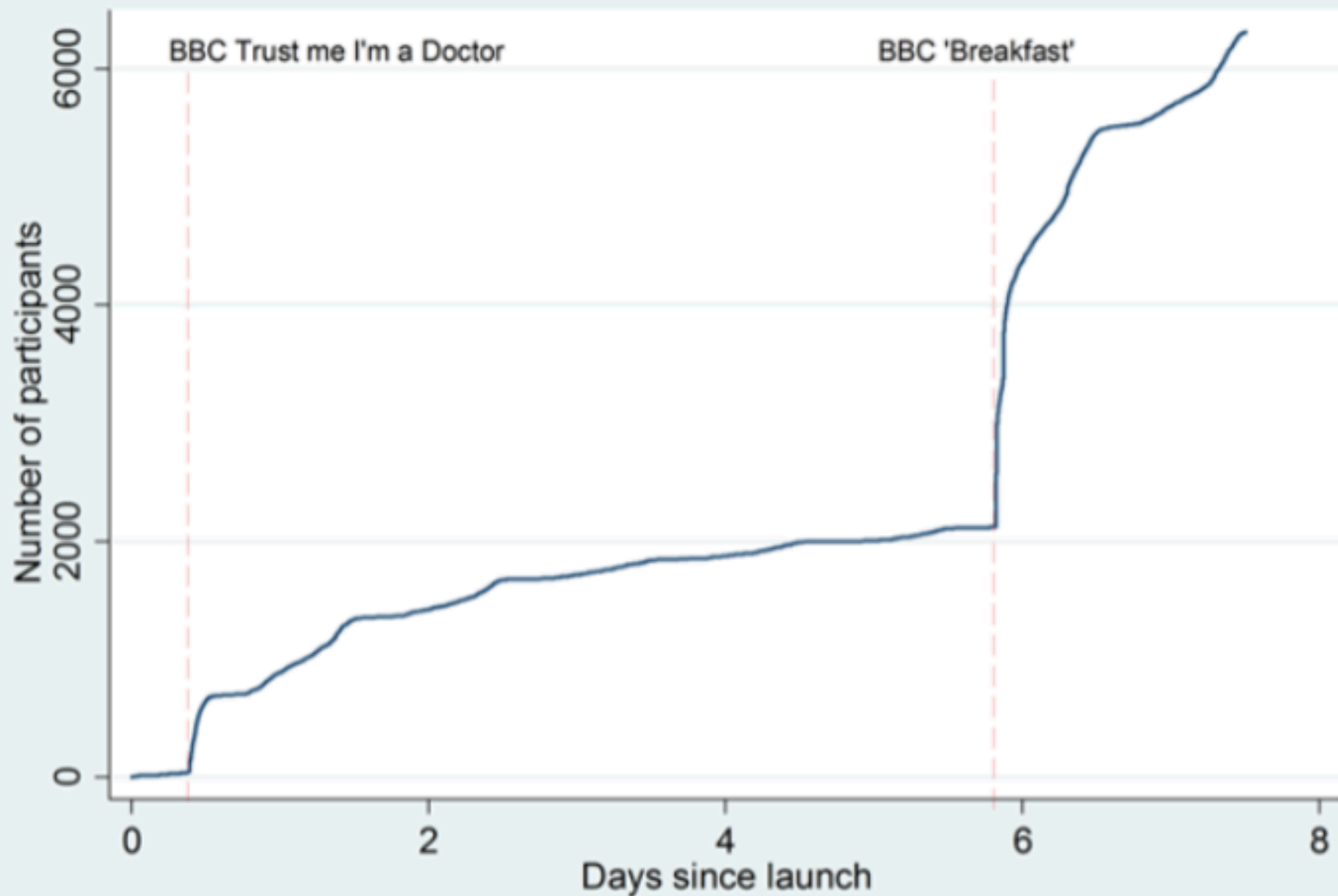
Can I avoid, or treat, arthritis?

Chris' simple arthritis exercises, and join in the big arthritis & weather experiment

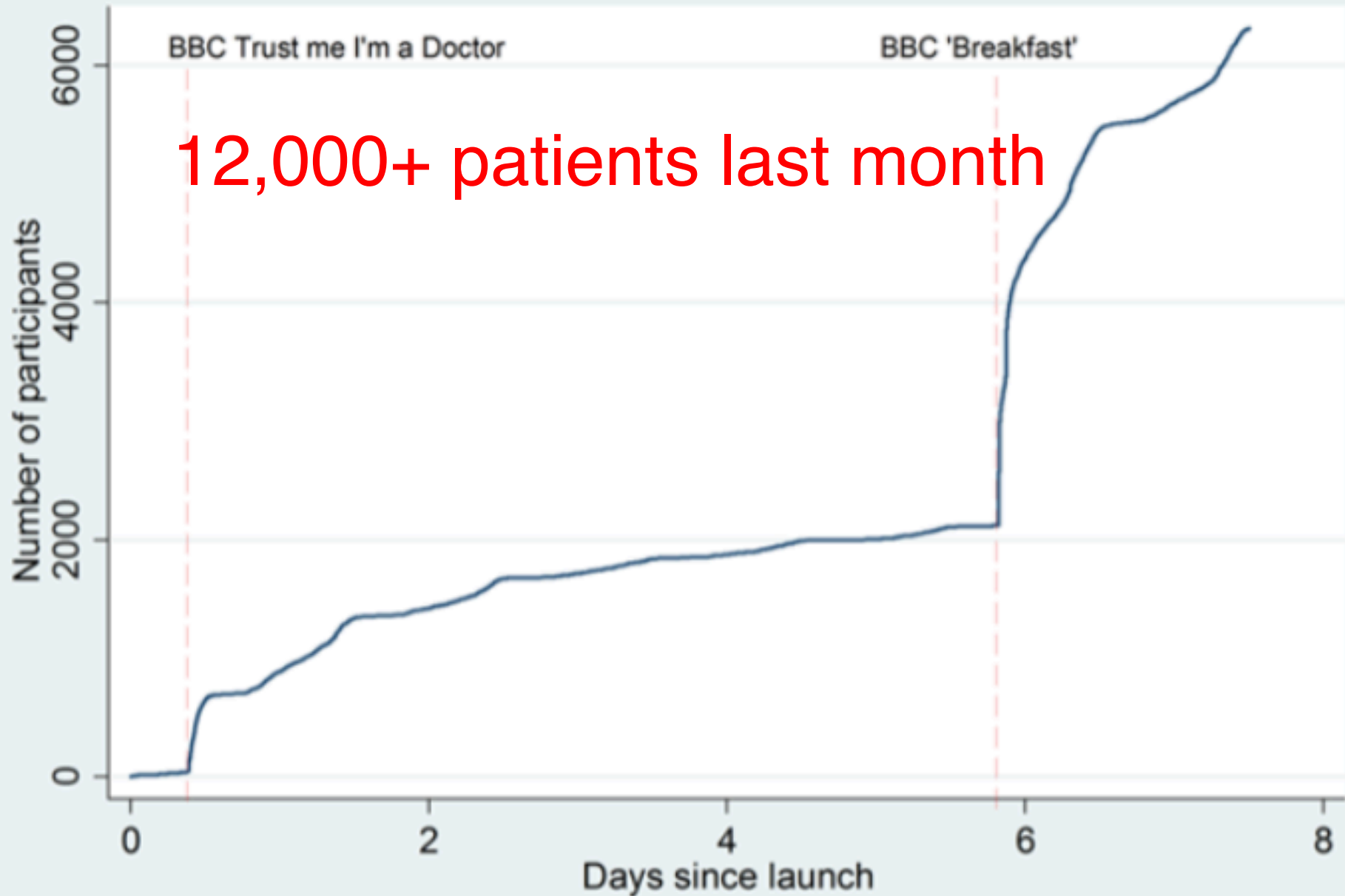
- **Sign up to take part in the study**
(www.cloudywithachanceofpain.com)



Cumulative enrolment in 1st week



Cumulative enrolment in 1st week



Data collection is still ongoing...

But we have a few preliminary results about the data we're collecting that may help others doing mHealth (mobile Health) studies.

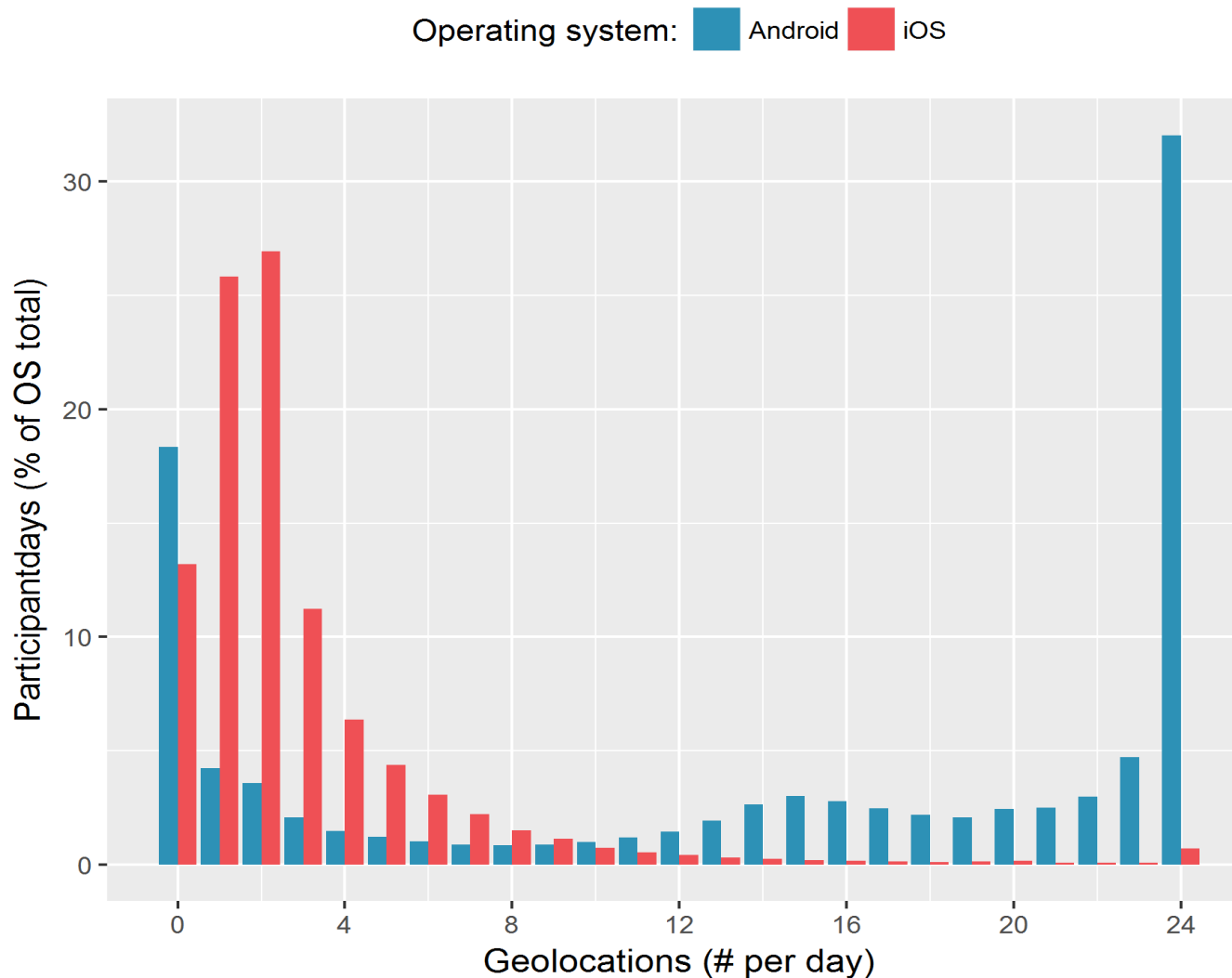
Four clusters of participant engagement

Over a 143–183-day period:

14%	averaged	175	days data entry	→	high engagement
22%	averaged	88	days data entry	→	moderate engagement
39%	averaged	8	days data entry	→	low engagement
25%	averaged	1	day data entry	→	tourists

Type of phone determines frequency of location reporting.

Geolocations retrieved per participantday
by operating system



Beukenhorst et al.
(2016, submitted)

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The Project

Take part

Explore the data

Citizen Science

Arthritis Research UK

Blog

You can help answer a 2300 year old question

Many people have wondered about how the weather affects health

This goes back as far as Hippocrates, the father of modern medicine who

Why do you need me to take part?

We need to collect data from lots of people throughout 2016 to create a big database. We can only uncover the relationship between weather and pain if we have data from a very large number of people.