PREDICTING COVID WITH 3 MILLION CITIZEN SCIENTISTS
COVID SYMPTOM STUDY APP

Tim Spector
@timspector
The COVID Symptom app: Predicting COVID-19

- 3.3 million users across the United Kingdom
- Predicts "Symptomatic COVID" via algorithm
- Can predict COVID using clusters of symptoms (as published in Nature Medicine)
- Aiding NHS and the Department of Health
- Perform real time research on risk factors

Why does it matter?
With 3 million users we can accelerate testing, support contact tracing, expedite a safe lockdown release and will be able to detect second wave quickly by region.

Not-for-profit initiative by health science company ZOE and King's College London
Endorsed and amplified by
We can predict "Symptomatic COVID" using Machine Learning

Symptom clusters

Extrapolate to population

Days with symptoms
## Model validation with testing from the Department of Health

<table>
<thead>
<tr>
<th>Infectious users</th>
<th>Government testing</th>
<th>Model is tested and improved</th>
</tr>
</thead>
<tbody>
<tr>
<td>Identified by the algorithm</td>
<td>PCA/Swab testing at testing centres across the country</td>
<td>When a user reports their results in the app, otherwise data is not shared with us</td>
</tr>
</tbody>
</table>

New prospective test of diagnostic algorithm planned compared to swab testing

Subset of 600 Twins having antibody tests as part of BRC study
Published scientific papers: 12+ more in pipeline

Real-time tracking of self-reported symptoms to predict potential COVID-19


Nature Medicine (2020) | Cite this article

Science

Rapid implementation of mobile technology for real-time epidemiology of COVID-19


Corresponding author. Email: achan@mgh.harvard.edu

1Clinical & Translational Epidemiology Unit, Massachusetts General Hospital and Harvard Medical School, 55 Fruit St, Boston, MA 02114, USA.
2Department of Twin Research and Genetic Epidemiology, King’s College London, Westminster Bridge Road, London SE1 7TN, UK.
3Department of Ageing and Health, Guy’s and St. Thomas’ NHS Foundation Trust, Lambeth Palace Road, London SE1 7EH, UK.
4School of Biomedical Engineering & Imaging Sciences, King’s College London, 1 Lambeth Palace Road, London SE1 7JE, UK.
5Zoe Global Limited, 164 Westminster Bridge Road, London SE1 7JE, UK.
6Department of Immunology and Infectious Diseases, Harvard T. H. Chan School of Public Health, 645 Huntington Avenue, Boston, MA 02114, USA.

* These authors contributed equally to this work.
+ These authors contributed equally to this work.
*gi COPE Consortium members and affiliations are listed in the supplementary materials.
+ Hide authors and affiliations

Science. 03 May 2020

DOI: 10.1126/science.abc0473

• Deprivation
• Genetics
• Obesity
• Smoking
• Health care workers
• Prediction of admissions
• HRT
• Vitamins
Incidence rates across England over the last 14 days by region – based on DHSc swab tests

<table>
<thead>
<tr>
<th>Region</th>
<th>reg_healthy</th>
<th>newly_sick</th>
<th>invited</th>
<th>tested</th>
<th>tested_positive</th>
<th>% newly sick</th>
<th>% invited</th>
<th>% tested</th>
<th>% tested positive</th>
<th>% +ve 95% lolim</th>
<th>% +ve 95% uplim</th>
</tr>
</thead>
<tbody>
<tr>
<td>East of England</td>
<td>136305.0</td>
<td>11455.0</td>
<td>10411.0</td>
<td>2384.0</td>
<td>32.0</td>
<td>7.752436</td>
<td>90.886076</td>
<td>22.898857</td>
<td>1.342282</td>
<td>0.880345</td>
<td>1.804218</td>
</tr>
<tr>
<td>London</td>
<td>185214.0</td>
<td>14432.0</td>
<td>13076.0</td>
<td>2978.0</td>
<td>33.0</td>
<td>7.223795</td>
<td>90.604213</td>
<td>22.774549</td>
<td>1.106126</td>
<td>0.732150</td>
<td>1.484103</td>
</tr>
<tr>
<td>Midlands</td>
<td>138105.0</td>
<td>12009.0</td>
<td>10779.0</td>
<td>2388.0</td>
<td>44.0</td>
<td>7.999920</td>
<td>89.757682</td>
<td>22.154189</td>
<td>1.842545</td>
<td>1.303157</td>
<td>2.381935</td>
</tr>
<tr>
<td>North East and Yorkshire</td>
<td>115985.0</td>
<td>10301.0</td>
<td>9312.0</td>
<td>2125.0</td>
<td>37.0</td>
<td>8.158882</td>
<td>90.398990</td>
<td>22.829017</td>
<td>1.741175</td>
<td>1.185047</td>
<td>2.297306</td>
</tr>
<tr>
<td>North West</td>
<td>94747.0</td>
<td>8282.0</td>
<td>7487.0</td>
<td>1654.0</td>
<td>39.0</td>
<td>8.039513</td>
<td>90.400869</td>
<td>22.091525</td>
<td>2.357920</td>
<td>1.626674</td>
<td>3.089166</td>
</tr>
<tr>
<td>South East</td>
<td>233042.0</td>
<td>18626.0</td>
<td>16964.0</td>
<td>4329.0</td>
<td>51.0</td>
<td>7.401020</td>
<td>91.079898</td>
<td>25.518746</td>
<td>1.176101</td>
<td>0.856682</td>
<td>1.499521</td>
</tr>
<tr>
<td>South West</td>
<td>132133.0</td>
<td>10904.0</td>
<td>9899.0</td>
<td>2191.0</td>
<td>22.0</td>
<td>7.623202</td>
<td>90.783199</td>
<td>22.133549</td>
<td>1.004108</td>
<td>0.586637</td>
<td>1.421578</td>
</tr>
<tr>
<td>England</td>
<td>1035531.0</td>
<td>86009.0</td>
<td>77926.0</td>
<td>10049.0</td>
<td>258.0</td>
<td>7.668830</td>
<td>90.604472</td>
<td>23.161123</td>
<td>1.426442</td>
<td>1.256279</td>
<td>1.602614</td>
</tr>
</tbody>
</table>
Rapid implementation of mobile technology for real-time epidemiology of COVID-19

David A. Drew1*, Long H. Nguyen1*, Claire J. Steves2,3, Cristina Menni2, Maxim Freydin4, Thomas Varsavsky4, Carole H. Sudre4, M. Jorge Cardoso4, Sebastien Ourselin4, Jonathan Wolf5, Tim D. Spector2,5†, Andrew T. Chan1,6+,*, COPE Consortium§

Real-time tracking of self-reported symptoms to predict potential COVID-19

Cristina Menni1,7,8, Ana M. Valdes1,2,7, Maxim B. Freydin1, Carole H. Sudre3, Long H. Nguyen4, David A. Drew4, Sajaysurya Ganesh5, Thomas Varsavsky3, M. Jorge Cardoso3, Julia S. El-Sayed Moustafa1, Alessia Visconti1, Pirro Hysi1, Ruth C. E. Bowyer1, Massimo Mangino1,6, Mario Falchi1, Jonathan Wolf5, Sebastien Ourselin3, Andrew T. Chan4, Claire J. Steves1,8

1The Francis Crick Institute
Symptoms predictive of a positive Covid-19 PCR test in 2.816 Million respondents in UK and USA

- Loss of smell
- Skipped meals
- Fatigue
- Fever
- Persistent cough
- Diarrhea
- Delirium
- Hoarse voice
- Shortness of breath
- Abdominal pain
- Chest pain

Graph showing the odds ratio (OR) for each symptom with United Kingdom and United States data.

- AUC = 0.76 (0.74-0.78)
- SE = 0.65 (0.62-0.67)
- SP = 0.78 (0.76-0.80)
- PPV = 0.69 (0.65-0.71)
- NPV = 0.73 (0.73-0.77)
IS sense of smell important?
COVID subtypes – 5 clusters of increasing respiratory severity
Symptom duration on 2000 swab positives on whom we had daily data for 40 days