

about vaccines. We performed a multilevel study to categorize the accounts and to identify the most relevant hashtags.

We analysed 869 accounts and categorized 373 of them:

- 85 belonged to health professionals (47 doctors, 15 paediatricians, 14 researchers, 6 epidemiologists and 3 healthcare assistants)
- 47 were media outlets
- 32 belonged to politicians
- 4 were public organizations

Public institutions (i.e. White House, WHO, CDC, Gates Foundation), politicians and media (i.e. Fox News) were the most popular accounts. Organisations and charities were highly represented too. Among personal accounts, Nancy Pelosi, Democrat spokesperson at the US Congress, has the highest number of followers (900K), followed by Jake Tapper (CNN journalist, 500K) and Jakaya Kikwete (former Tanzania president, actually involved in the promotion of vaccination campaigns). Ten accounts declared a family history related to supposed vaccine injury.

Category	Count	Post	Follower	P
(blank)	496	13292332	26876227	26
journalist	71	1685870	2600534	23
organisation	57	582960	4056623	10
newspaper	47	1874249	5773278	39
physician	47	773348	211327	16
politician	32	313286	15747741	9
public health institutions	20	183796	5761062	9
paediatrician	15	90952	63016	6
employees of public institutions	14	105235	199250	75
researcher	14	115605	60007	8
community	12	228874	190905	19
Family history vax injury	10	379970	30501	37
company	7	92288	244166	13
epidemiologist	6	66284	7039	11
university	6	97328	22400	16
public institutions	4	50505	2471558	12
activist	2	107219	25798	53
entomologist	2	47788	6610	23
nurse	2	39076	3776	19
teacher	2	104103	9589	52
associations	1	682	274	6
paramedic	1	57	47	57
pharmacist	1	19893	3314	19
TOT	869	20251700	64365042	23

Most of the users used hashtag to describe their activity on Twitter, the most relevant being #CDCwhistleblower. This hashtag is strongly connected with the movie VAXXED ^[13] released on 2016 and directed by Andrew Wakefield. This is a well-known name: in 1998, Wakefield published a study in *The Lancet* suggesting that vaccines caused autism. In 2010, the study was retracted following the report of serious ethical violations by Wakefield himself, whose UK medical

license was then revoked. The movie is based on a conspiracy theory according to which there is a CDC whistleblower who revealed that the CDC manipulated the results of a study showing a link between vaccines and autism. The study ^[14] performed by two CDC employees, Frank De Stefano and William Thompson confirmed that there is no evidence that children with autism were more likely to have received their first MMR vaccine earlier than neurotypical controls. However, a review of the same data ^[15] led to a different conclusion, according to its author Brian Hooker ^[16]: there is a strong correlation between MMR vaccine and autism in black male children who received the shot within their first 36 months of life. The Hooker's paper was retracted too ^[15], due to undeclared competing interests on the part of the author and post-publication concerns about the validity of the methods and statistical analysis. Moreover, Thompson the whistleblower was not aware of being recorded over the phone and never watched the movie before its release. Nevertheless, the anti-vaccine movement continues to consider this story as a clear proof of public health institutions attempts to hid the truth about vaccines.

Following #CDCwhistleblower, our analysis found other relevant hashtags, as shown in the following table:

#	count
CDCwhistleblower	5
innovation	4
globalhealth	3
medicine	3
repealthe8th	3
science	3
truth	3
autism	2
CCOT	2
GIS	2
health	2
healthcare	2
homeopathy	2
politics	2
publichealth	2
research	2
Skeptic	2
tweetiatrician	2
vaccines	2

Geographical distribution

It is interesting to note that 52 users described themselves as a mom, while 28 as a dad. Among medical conditions explicitly cited in the accounts, we found 6 references to cancer and autism.



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Links

- [1] <http://www.asset-scienceinsociety.eu/target/citizens>
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- [12] <http://www.asset-scienceinsociety.eu/pages/twitter-influencer-analysis>
- [13] <https://en.wikipedia.org/wiki/Vaxxed>
- [14] <https://www.ncbi.nlm.nih.gov/pubmed/14761240>
- [15] <https://translationalneurodegeneration.biomedcentral.com/articles/10.1186/2047-9158-3-22>
- [16] [https://en.wikipedia.org/wiki/Brian_Hooker_\(bioengineer\)](https://en.wikipedia.org/wiki/Brian_Hooker_(bioengineer))