

# Consumer Informatics and One Health: Shifting the Focus from the Individual to the Globe. Findings from the Yearbook 2023 Section on Education and Consumer Health Informatics

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## Summary

**Objective:** To summarise the state of the art during the year 2022 in consumer health informatics and education, with a special emphasis on “One Health”.

**Methods:** We conducted a systematic search of articles published in PubMed. We build queries to merge terms related to “consumer health informatics”, “one health”, and “digital”. We retrieved 94 potential articles for review. These articles were screened according to topic relevance and 12 were selected for consideration of best paper candidates, which were then presented to a panel of international experts for full paper review and scoring. The top five papers were discussed in a consensus meeting. Three papers received the highest score from the expert panel, and these papers were selected to be representative papers on consumer informatics for exploring one health from consumer perspective in the year 2022.

**Results:** Bibliometrics analysis conducted on words found in abstracts of the 12 candidate papers revealed four clusters of articles, where clustering outcomes explained 96.91% of the dispersion. The

first cluster composes three papers related to patient engagement in primary care practices, using digital-delivered diabetes prevention programmes, or exploring citizen involvement in co-designing environmental projects (such as air pollution exposure and health). The second cluster represents four papers related to digital health literacy and consumer behavior, such as digital vaccine literacy, and food labelling influences and whether displaying Nutri- and Eco-Score at food product level led to improved consumer choices. The third cluster consists of two papers exploring strategies to involve citizens in various science projects while analyzing the quality of citizen-collected data (e.g., mosquito bites or gastropod community dataset). The last cluster contains three papers related to the relationships between human behavior with their environment and their contribution to citizen science projects (e.g., biological water quality in the Netherlands distribution, composition, abundance of debris across sandy beaches in Australia and its regions, urbanization and reptile biodiversity across Florida).

**Conclusion:** Traditionally, consumer health informatics focuses on providing individuals with tools and resources to actively man-

age their own health. By incorporating a global health (or one health) perspective, our field is now at a crossroad, demanding us to think beyond the individual and challenging us to instill the thinking that our actions not only have consequences on the individual but also on the population and the environment. Perhaps this is also a reflective time for the consumer informatics field, to consider shifting the focus from the individual to one that is more aligned with one health, helping consumers gain awareness of how their actions impact on the individual, the population and the environment, and providing them with tools to work collectively to help decide how their actions may bring benefits (as well as harms) across these levels.

## Keywords

Consumer health informatics; health literacy; digital literacy; citizen science projects; One Health

Yearb Med Inform 2023;158-68

<http://dx.doi.org/10.1055/s-0043-1768749>

## 1 Introduction

Broadly speaking, consumer health informatics and global health are two interconnected fields that have significant relationships and influences on each other. “Consumer Health Informatics”, or CHI, is a term for the subfield of informatics that focuses on consumer and patient perspectives, simultaneously as users and beneficiaries of information systems that empower them to manage their *own* health [1]. By enabling individuals to access and

understand health information, make informed decisions, and engage in self-care, consumer health informatics contributes to improving individual health outcomes globally. Global health initiatives aim to address health disparities and improve health outcomes worldwide, particularly in underserved communities.

‘One Health’ is an “integrated, unifying approach to balance and optimize the health of people, animals and the environment” [2]. It is particularly important to prevent, predict, detect, and respond to global health

threats such as the COVID-19 pandemic [2]. Benis *et al.* [3] conceptualized the One Digital Health Steering Wheel framework. One Digital Health (ODH) aims to facilitate and improve collaboration among practitioners in One Health and Digital Health Communities. This collaboration allows both communities to benefit from efficient interactions over time and the delivery of near-real-time, data-driven contributions to systems medicine [4] and systems ecology [5]. It will also allow citizens to engage with their individual health and well-being.

One of the challenging key issues that ODH must face is collecting and managing critical indicators that are related to human, plant and veterinary health care, education, citizen engagement, environmental observation, agronomy, health care and the food industry. Ho [6] proposes for a dedicated global ODH framework—centred on fairness and equity—to be established to promote data-sharing across all the key knowledge domains of OH and to devise data-driven solutions to challenges in the human-animal-ecosystems interface. He identifies the data landscape in relation to (1) Human and population health; (2) Pathogens; (3) Animal and plant health; and (4) Ecosystems and biodiversity. His framework is based on a syndemic approach where data to be shared and aggregated could be molecular (*e.g.*, genomic, serological, and metabolic data), observational (*e.g.*, body temperature, weight, feed intake and nutrient quality according to front-of-package nutrition labelling [7]), agronomical (*e.g.*, herd structure, breeding, sanitation), agricultural (or on land use or land cover, more generally), epidemiological, demographical, commercial, financial (median monthly or annually incomes), meteorological, pollutant data (air, soil and water), and so forth.

One Health and consumer health informatics intersect in promoting a holistic approach to health, leveraging data for disease surveillance and monitoring, incorporating animal and environmental health information, and utilizing data analysis techniques to enhance health education, awareness, and collaboration. By integrating consumer health informatics within the One Health framework, individuals can gain a broader understanding of health issues, including zoonotic diseases, environmental factors, and the impact of animal health on human health. By synergizing these two fields, we have great potential to strengthen our understanding of the interdependencies between human, animal, and environmental health, leading to improved health outcomes for all.

For this paper, our purpose was to identify significant papers published in 2022, illustrating how One Health and Consumer Health Informatics complement each other. To ensure we cover a broad spectrum of topics, we have *not* restricted to specific areas

that are commonly associated with these two areas, such as disease surveillance and early detection, data integration and analysis, behavioural insights for behaviour change, enhanced health education, collaboration and communication, or policy development and resource allocation.

## 2 Methodology

### 2.1 Search Strategy

We used PubMed to conduct our search, capturing papers on consumer-using technologies and one health concern published in the year 2022. At the time we explored PubMed to find the candidate best papers, the basic query using MeSH terms (“One Health”[Mesh]) AND (“Consumer Health Informatics”[Mesh]) retrieved zero articles. Thus, we refined the choice of keywords according to the previous “one health” frameworks described above. The query we used is composed of four parts: the first is a classic set of filters (year of publication and publication types), the second is related to the section “consumer health informatics”, the third is a set of terms related to the components of “one health” and the sources of data, and the last one lists all the terms related to “digital”. The syntax “[All Fields]” was used wherever possible to ensure our search strategy was comprehensive. The final search query is listed below:

(2022/1/1:2022/12/31[DP] NOT “Epub ahead of print”) NOT Bibliography[pt] NOT Comment[pt] NOT Editorial[pt] NOT Letter[pt] NOT News[pt] NOT Case Reports[pt] NOT Published Erratum[pt] NOT Historical Article[pt] NOT Legal Case[pt] NOT legislation[pt] NOT (systematic review[pt] OR “review literature as topic”[MeSH Terms] OR “review”[All Fields])

AND

(“consumer health informatics”[MeSH Terms] OR “consumer health information”[MeSH Terms] OR “consumer behavior”[MeSH Terms] OR “consumer attitude”[All Fields] OR “consumer organizations”[MeSH Terms])

AND

(“syndemy”[All Fields] OR “global health”[All Fields] OR “planetary

health”[All Fields] OR “human health”[All Fields] OR “population health”[All Fields] OR “pathogens”[All Fields] OR “animal health”[All Fields] OR “plant health”[All Fields] OR “ecosystems”[All Fields] OR “biodiversity”[All Fields] OR “molecular data”[All Fields] OR “observational data”[All Fields] OR “agronomical data”[All Fields] OR “agricultural data”[All Fields] OR “epidemiological data”[All Fields] OR “demographical data”[All Fields] OR “commercial data”[All Fields] OR “financial data”[All Fields] OR “meteorological data”[All Fields] OR “pollutant data”[All Fields])

AND

(“digital health”[All Fields] OR “ehealth”[All Fields] OR “e-health”[All Fields] OR “tele-health”[All Fields] OR “mhealth”[All Fields] OR “m-health”[All Fields] OR “mobile health”[All Fields] OR “telemedicine”[All Fields] OR “electronic patient-physician communication”[All Fields] OR “electronic medical record”[All Fields] OR “electronic health record”[All Fields] OR “personal health record”[All Fields] OR “electronic patient record”[All Fields] OR “electronic”[All Fields] OR “information technology”[All Fields] OR “communication technology”[All Fields] OR “mobile”[All Fields] OR “cell phone”[All Fields] OR “smart phone”[All Fields] OR “online”[All Fields] OR “online systems”[All Fields] OR “internet”[All Fields] OR “web”[All Fields] OR “website”[All Fields] OR “patient portal”[All Fields] OR “tele\*”[All Fields] OR “digital\*”[All Fields] OR “remote\*”[All Fields] OR “video\*”[All Fields] OR “virtual”[All Fields] OR “virtuality”[All Fields] OR “virtualization”[All Fields] OR “virtualized”[All Fields] OR “virtualizing”[All Fields] OR “virtuals”[All Fields])

### 2.2 Bibliometrics Analyses

To understand the state of the literature, we applied various bibliometrics tools onto the original set of articles returned from the search query. The “Bibliometrix” package from R [8] was used on the citation set of retrieved articles. We reported frequency of keywords. We illustrated the analysis of abstracts (measure of word frequency) by a

word cloud drawing feature. We analysed keywords to uncover links between concepts through co-occurrences network. We also plotted a thematic map to analyse these clusters according to the quadrant in which they are placed [9].

- Themes in the *upper-right* quadrant are both well-developed and important for the structuring of a research field. They are known as the motor-themes of the specialty given that they present strong centrality and high density;
- Themes in the *upper-left* quadrant have well-developed internal ties but less-developed external ties and so are of only marginal importance to the field. These themes are very specialized and peripheral in character;
- Themes in the *lower-left* quadrant are both weakly-developed and marginal. The themes of this quadrant have low density and low centrality, mainly representing either emerging or disappearing themes;
- Themes in the *lower-right* quadrant are important for a research field but are not as well-developed. Each theme is

represented as a sphere, its volume being proportional to the number of documents associated with the theme.

## 3 Results

### 3.1 State of the Literature

A descriptive analysis of 94 articles was conducted, reporting the frequency of keywords, and the frequency of words in titles and abstracts. 480 distinct bigrams in titles and 5,418 bigrams in abstracts were used. Figure 1 lists the 50 most frequently cited bigrams in abstracts ranked from most frequently to least frequently reported. The top ten is composed of: health literacy (139 times), digital health (31 times), citizen science (28 times), eHealth literacy (26 times), mental health (23 times), added sugar (21 times), health care (20 times), breast cancer (17 times), health information (17 times), and public health (15 times).

Regarding the conceptual structure of the set of 94 articles, Figure 2 shows the

co-occurrences of bigrams. Four blocks of co-occurrences have been identified. The biggest one is centred on “health literacy”. One is centered on “citizen science”. The remaining two identify “consumer behaviour” and “patient participation”.

Regarding thematic maps of keywords found in abstracts (Figure 3), clusters according to centrality (relevance degree) and density (development degree) are reported in each quadrant. The most common themes found across papers are related to “health literacy” and “community participation”. Niche themes revealed by this analysis are represented by “consumer behaviour” and “food preferences”. The cluster “citizen science” is classified as an emerging theme.

The analysis of these first metrics allows us to see that the terms at the intersection of “consumer health information” and “global health” are “health literacy”, “consumer/patient engagement” and “community participation”, “consumer behaviour” and “citizen science”. Whether we take the keywords or the terms of the abstracts, the respective analyses are consistent.

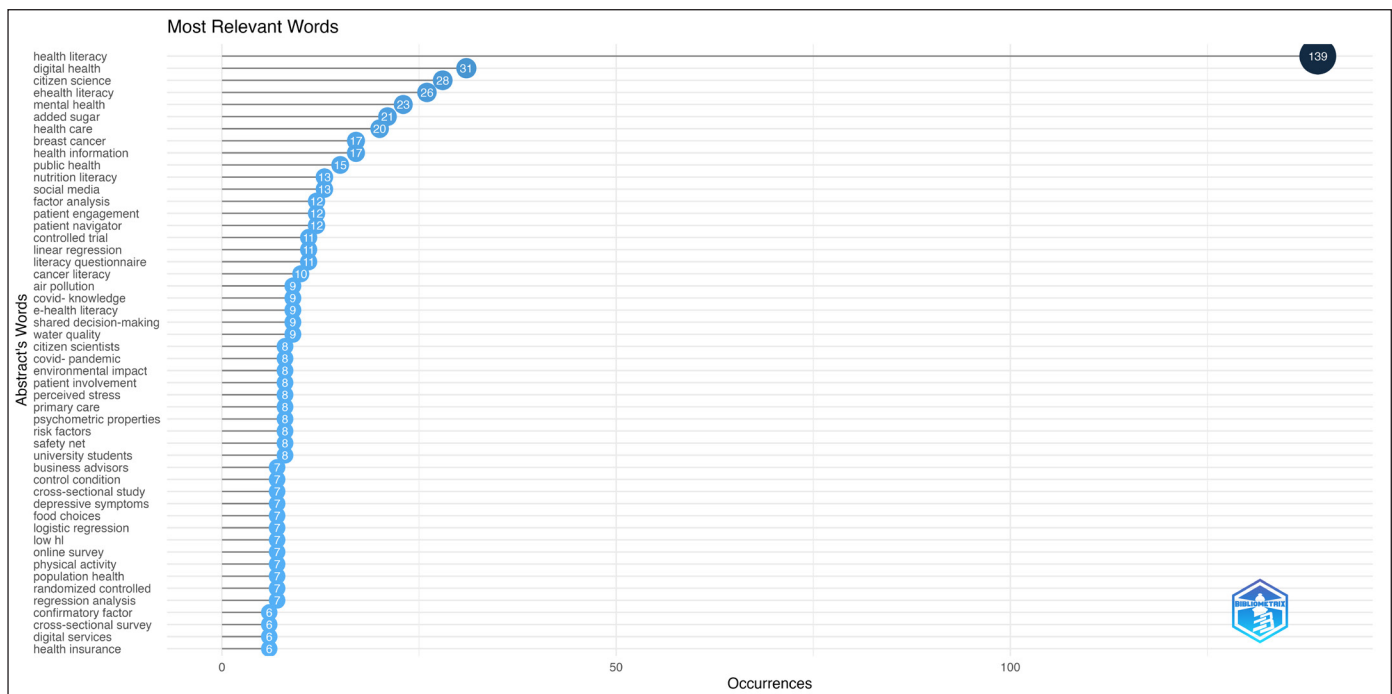


Fig. 1 Occurrences of bigrams in abstracts of the first selection of 94 papers.

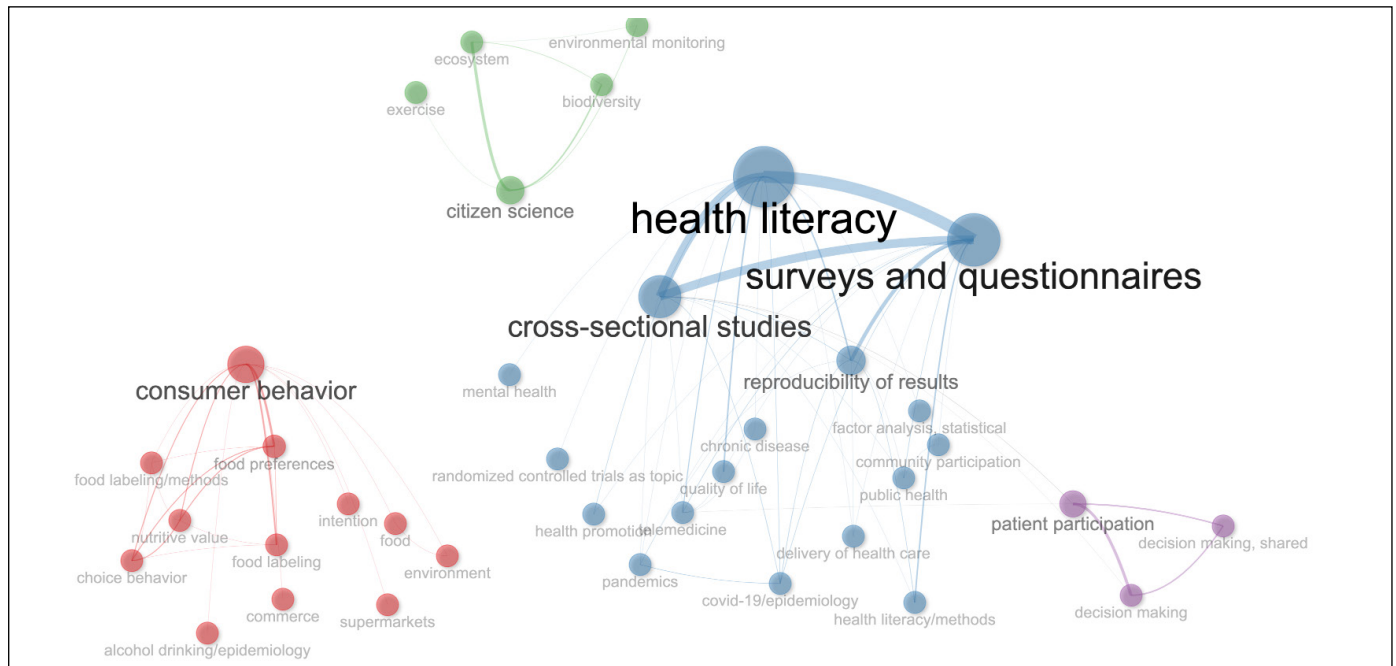


Fig. 2 Co-occurrence network of the most frequent abstracts bigrams (original set of 94 papers)

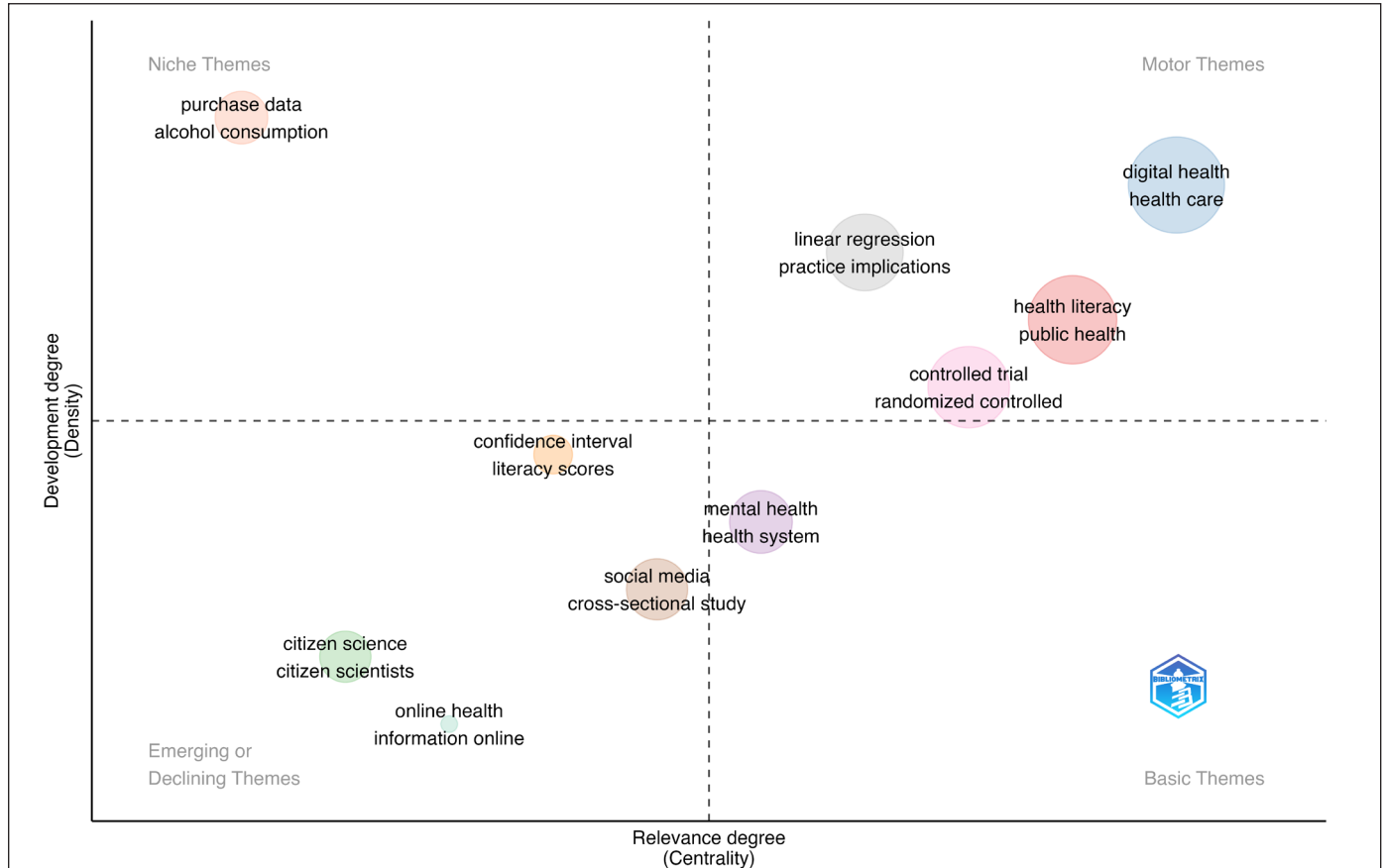


Fig. 3 Thematic map of clusters of keywords (original set of 94 papers)

### 3.2 Best Paper Selection

To identify the 12 candidate papers, co-editors independently assessed the 94 retrieved papers using the Rayyan web tool [10], followed by a discussion. Elements that were considered in the screening decision include 1) the level of relevance regarding the 2022 Yearbook topic “global health and consumer health informatics”; 2) whether the study was focused only on patients and consumers; 3) the nature of the issues addressed; and 4) level of innovative approach and methodological design.

The 12 articles were then presented to a panel of international experts for full paper review and scoring according to the IMIA Yearbook best paper selection process. The final selection of best papers is completed after discussions at the annual IMIA Yearbook board meeting. We applied the same metrics to analyse the set of the 12 best papers selection. 59 distinct keywords were used, 71 distinct bigrams in titles and 891 words in abstracts. The top ten keywords are listed in Table 1.

The co-occurrence network of abstracts bigrams is shown in Figure 4. Four clusters are described. The main two clusters are centred on “digital health” and “citizen science”. We also analysed the conceptual structure of the selection by means of a multiple correspondence analysis based on words of abstracts (Table 2). The result clustering explains (96.91%) of the dispersion (Figure 5). This clustering of best-candidate best papers was blinded to the reviewers.

- Cluster 1. Three papers have been grouped in this cluster and are related to patient engagement. The first [11] aimed to estimate the use of health IT in primary care practices. Authors explored domains of patient engagement, population health management (decision support and registries), and electronic information exchange. The second [12] aimed to develop and test a digital health acceptability model of factors influencing the intention of adults living in Ireland to use a digital-delivered diabetes prevention programme. The third [13] is centered on an innovative project related to environmental epidemiology in which citizens codesign with scientists a study

**Table 1** List of the top ten keywords of the 12 selected articles

Words	Occurrences
citizen science	5
surveys and questionnaires	4
biodiversity	3
cross-sectional studies	3
ecosystem	3
health literacy/methods	2
reproducibility of results	2
air pollution/analysis/statistics & numerical data	1
anthropogenic effects	1
choice behavior	1

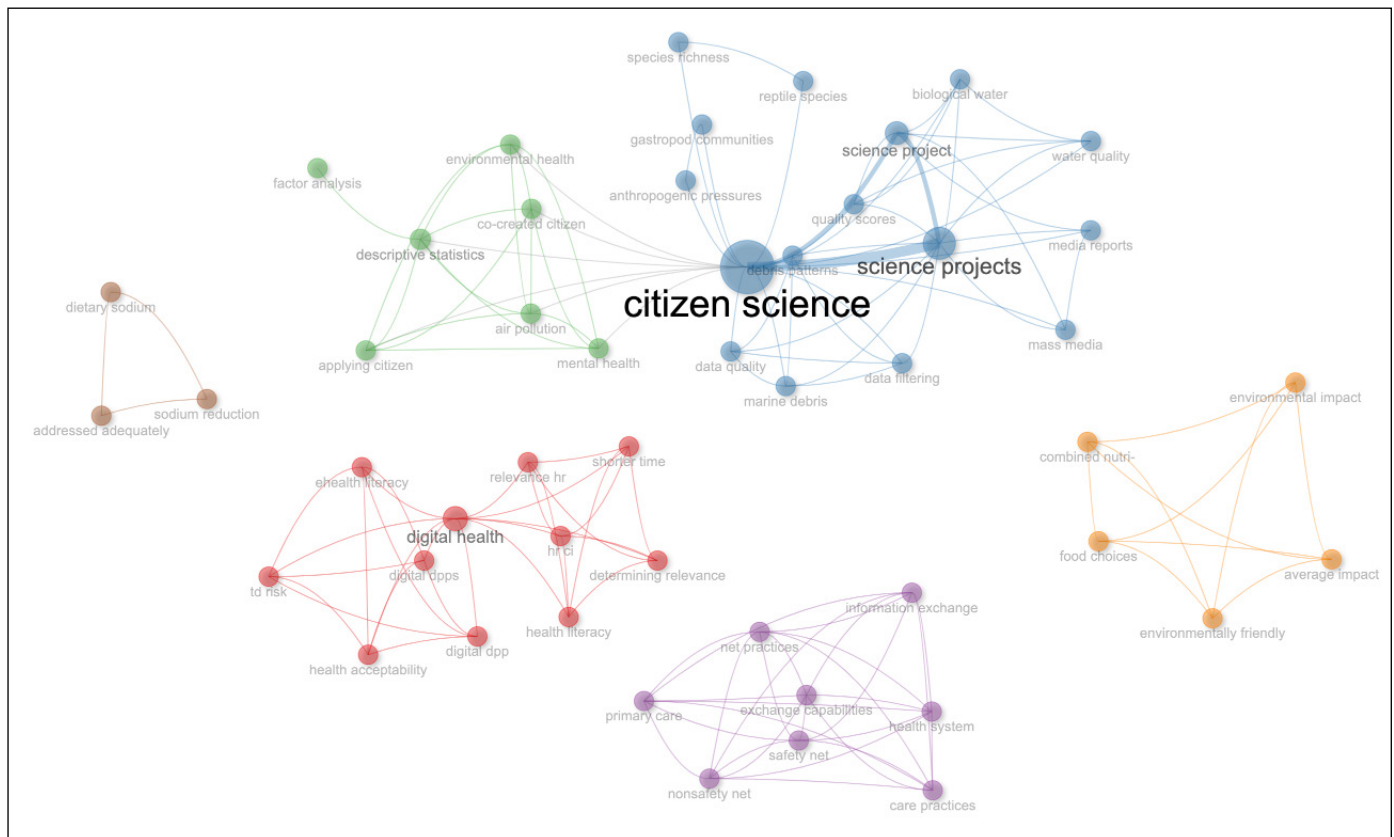
to assess the link between air pollution exposure and health;

- Cluster 2. This second cluster consists of four papers centered on digital health literacy and consumer behavior. The first [14] study aimed to evaluate associations between information searching on public health, social measures, and university students’ digital health literacy related to the SARS-CoV-2 and COVID-19 during the first wave of the pandemic in Portugal and associated university closures. Compared to those who never searched for information on environmental, economic and psychosocial issues, those who did are more likely to determine the relevance of content related to new coronavirus and COVID-19 on internet sources such as forums or social media. The second [15] study aimed to evaluate the quality of information and guidance on dietary sodium reduction available on consumer-facing websites. Consumers seeking information and guidance on dietary sodium reduction will find that most available websites provide accurate but limited information and insufficient guidance on how to lower sodium intake. The third [16] aimed to develop a tool measuring “Digital Vaccine Literacy” and assess its psychometric properties among a sample of French adults. The first subdimension (items 2 and 4) refers to understanding and trusting official information about vaccination provided

by institutional websites. The second subdimension (items 1 and 5) refers to understanding and trusting information about vaccines as provided by social media. The fourth [17] explored the potential of several digital functionalities in an E-grocery environment to stimulate more healthy and pro-environmental food choices. They conducted a randomized control trial in a mock-up E-grocery. A representative sample of Belgian consumers ( $n = 1,000$ ) selected food products for one meal for their daily household. Indices reflecting the nutritional quality (NQI) and environmental impact (EI) of selected food baskets were calculated. These findings suggest that displaying Nutri- and Eco-Score at the product level led to improved nutritional qualities of food choices, while the environmental impact was not reduced;

- Cluster 3. This cluster contains two papers exploring ways to involve citizens in science projects. The first [18] paper involved gaining insights into the connection between media coverage and the activation of citizens to participate in citizen science projects. As the factors triggering people to attract mosquito bites for science are still unknown, the authors analyzed the influence of mass media reports on mosquito submission numbers. They explored how effective a mass media approach turned out and thus provide insights for the targeted





**Fig. 4** Co-occurrence network of the most frequent abstracts bigrams (set of 12 selected best candidate papers)

design of communication strategies for other citizen science projects. They found that an already heightened public and media awareness of mosquito-relevant topics combined with a direct call to action in a media report led to maximum participation. In the second study [19], investigators used a citizen science-based dataset to explore key drivers of variability in gastropod communities associated with canopy-forming brown macroalgae from North-Eastern (NE) Atlantic rocky shores. They considered that when protocols and training followed by non-scientific citizens, the quality of collected data can be equivalent to the ones collected by researchers. The authors concluded that this work sheds light on the value of a citizen science program resulting from consultation between professional and citizen volunteers as a useful and efficient tool to investigate large-scale processes;

- Cluster 4. This cluster is composed of three papers that link human behavior with their environment. The first study [20] assessed the quality of data from a citizen science project related to biological water quality assessment in the Netherlands. Authors compared data collected by volunteers in an unstructured way with those collected according to quality protocols by professionals employed at regional water authorities by focusing on (1) the spatial and temporal distribution of the samplings, (2) the investigated water types and patterns in both datasets with respect to (a) calculated water quality scores and (b) the sampled macroinvertebrate communities. Information gathered via citizen science on biological water quality in the Netherlands potentially adds to the information gathered by regional water authorities as volunteers collect data on other spatial

and temporal scales. Volunteers however collect data in a different way and their inventory is less complete. The second study [21] provides a methodology for the systematic filtering of a continental citizen science database, towards improving data quality and subsequently, inferring patterns in distribution, composition, and abundance of debris across sandy beaches in Australia and its regions. Authors expect that, as citizen science techniques and databases progress, there is a need to improve their accuracy and reliability in gathering scientific knowledge, to further their inclusion within management and decision-making. The last paper [22] is completely different from the previous ones and reflects the links between human behaviour and animal health. The study is environment-focused and examines the association between urbanization and reptile biodiversity across Florida, a

**Table 2** LFactorial analysis of the 12 selected candidate best papers groups according to four clusters based on the analysis of abstracts unigrams sorted by diminishing contribution.

Documents	dim1	dim2	contribution	cluster
Gignac F, 2022, Environ Health	-0.2	-0.74	37.58	1
Gacutan J, 2022, Sci Total Environ	0.73	0.39	29.44	4
Pernat N, 2022, Plos One	0.41	-0.52	23.88	3
de Bauw M, 2022, Appetite	-0.12	0.57	21.88	2
Montagni I, 2022, J Med Internet Res	-0.67	0.27	21.48	2
Peeters ETHM, 2022, Plos One	0.64	-0.02	15.28	4
van Rhoon L, 2022, Br J Health Psychol	-0.6	0.09	13.76	1
Cross DA, 2022, Med Care	-0.42	-0.3	12.41	1
Rosário R, 2022, Int J Environ Res Public Health	-0.55	0.13	12.36	2
Gainsbury AM, 2022, Sci Total Environ	0.43	0.13	7.8	4
Serranito B, 2022, Sci Total Environ	0.24	-0.1	2.82	3
Hussain T, 2022, J Clin Hypertens (greenwich)	0.11	0.11	1.32	2

**Table 3** Best paper selection of articles for the Consumer Health Informatics and Education section of the IMIA Yearbook of Medical Informatics 2022. The articles are listed in alphabetical order of the first author's surname.

Section
Consumer Health Informatics and Education
<ul style="list-style-type: none"> <li>▪ De Bauw M, De La Revilla LS, Poppe V, Matthys C, Vranken L. Digital nudges to stimulate healthy and pro-environmental food choices in E-groceries. <i>Appetite</i> 2022 May 1;172:105971. doi: 10.1016/j.appet.2022.105971.</li> <li>▪ Montagni I, Pouymayou A, Pereira E, Tzourio C, Schück S, Texier N, González-Caballero JL; CONFINS Group. Measuring Digital Vaccine Literacy: Development and Psychometric Assessment of the Digital Vaccine Literacy Scale. <i>J Med Internet Res</i> 2022 Dec 14;24(12):e39220. doi: 10.2196/39220.</li> <li>▪ Gignac F, Righi V, Toran R, Errandonea LP, Ortiz R, Nieuwenhuijsen M, Creus J, Basagaña X, Balestrini M. Co-creating a local environmental epidemiology study: the case of citizen science for investigating air pollution and related health risks in Barcelona, Spain. <i>Environ Health</i> 2022 Jan 12;21(1):11. doi: 10.1186/s12940-021-00826-8.</li> </ul>

subtropical/tropical biodiversity hotspot. This study elucidates the potential of moderately urbanized areas to harbor native reptile species. Moderately urbanized areas have a combination of green space and built-up space enabling both native and non-native reptile species to co-exist, leading to a greater species richness in these periurban areas across subtropical and tropical Florida.

Finally, three papers were selected as best papers after discussions at a consensus meeting at the May 5<sup>th</sup> 2023 IMIA Yearbook editorial meeting. They are listed in Table 3. See Appendix to read the description of

the three studies and the main results. These three articles obtained the maximum score, collated from the independent scores of each member in the assessment panel, based on the innovative level of the study, its methodological quality, and its scientific scope in the field of “Consumer Health Informatics”.

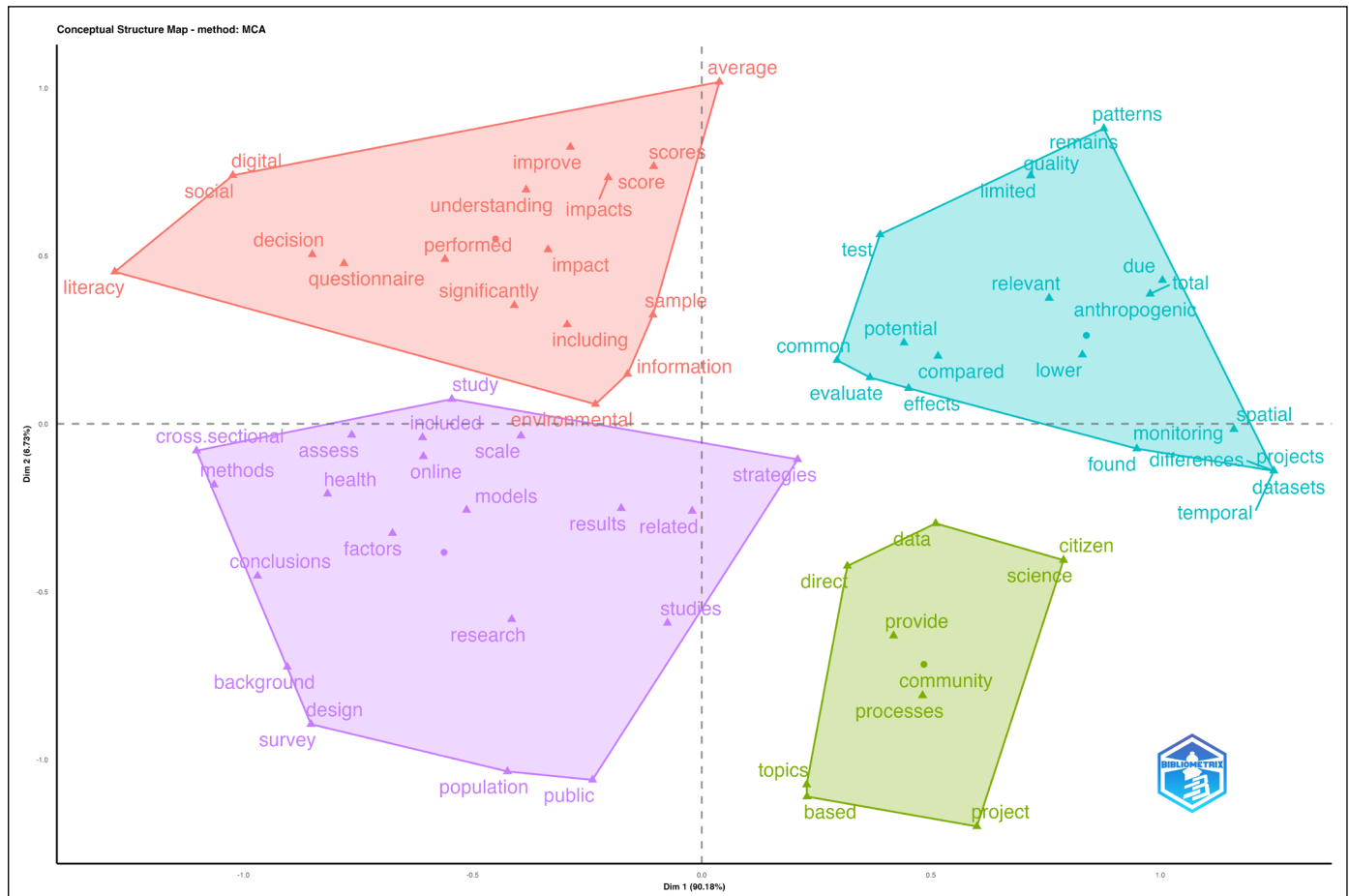
## 4 Conclusions

Making the link between “consumer health informatics” and “global heath” or “one health” is a promising approach that requires us to move beyond the usual boundaries of

personal care towards preventive health on a much broader scale. The aim is to focus on behaviors that enable citizens and patients to take responsibility not only for themselves, but also for the population and the environment. The articles submitted and the best papers selected address three facets of this commitment, in the field of understanding the impact of vaccination, guiding food choices based on product labelling, and assessing environmental exposure, particularly air pollution. One health is an active approach that involves citizens and patients. At the crossroad of consumer health informatics, the aim of one health is to instill the thinking that actions not only have consequences on the individual, but also on the population and the environment. It is important to ensure actions at any level (individual, population, environment) do not bring harm (intentionally or unintentionally) to any of the other levels. Involving people in citizen research projects is not new, but it is gradually evolving in connection with the digital transformation of society. By harnessing the collective power of individuals and technology, we can create a more inclusive, data-driven, and participatory approach to improving health for the individual, population and the environment.

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**Fig. 5** Factorial analysis of abstracts bigrams to clusterize the 12 selected best candidate papers

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## Appendix: Content Summary of Selected Best Paper for the IMIA Yearbook 2023, section Consumer Health Informatics

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Digital nudges to stimulate healthy and pro-environmental food choices in E-groceries

*Appetite* 2022 May 1; 172:105971. doi: 10.1016/j.appet.2022.105971. Epub 2022 Feb 16

Throughout the past decades, a switch to healthy and environmentally friendly diets has been promoted by countless Front-of-Package labels (FOP) on food products. Confusion and mistrust amongst consumers, caused by the wide diversity of existing FOP labels, could partly explain their limited role in consumers' food choices. From a nutrition point of view, the introduction of Nutri-Score in various European countries has been contributing to harmonisation. Moreover, evidence has shown that Nutri-Score could lead to healthier food choices among consumers and reformulation among producers. A similar standardisation is ongoing with the spread of Eco-Scores, reflecting products' environmental footprints (PEF). The goal of this study is to provide insights into the effectiveness of displaying both scores simultaneously, which is now increasingly done by retailers. As E-groceries have the capability to influence food choices by using smart and personalised nudges, this study also aimed to explore the potential of several digital functionalities in an E-grocery environment to stimulate more healthy and pro-environmental food choices. the following hypotheses were put forward: H1. Nutri- and Eco-Scores at the product level improve nutritional values of food choices more than environmental impacts. H2. Supporting these scores with personalised feedback and social norm increases their effectiveness. H3. Facilitating a food environment with recommendation agents increases the effectiveness of scores, personalised feedback, and social norm. A randomized control trial was con-

ducted in a mock-up E-grocery. In November 2019 in Flanders, a representative sample of Belgian consumers (n = 1,000) selected food products for one meal for their daily household. As in real E-groceries, this selection process was subdivided into two stages. Consumers apply different decision strategies in different phases of product choice. Therefore, two focus groups preceded this study to get insights into which phase the nudges would be most favoured by consumers. The sample was roughly representative for the Belgian population in terms of gender and age while being slightly overrepresented by respondents from higher income and educational classes. The findings suggest that displaying Nutri- and Eco-Score at product level led to improved nutritional qualities of food choices, while the environmental impact was not reduced. Respondents being exposed to the scores report to have relied significantly more both on Nutri-Score and on Eco-Scores compared to those who were not. On the one hand, the findings corroborate the growing body of literature indicating that Nutri-Score would be an effective communication tool for inducing healthier food choices among consumers. On the other hand, it confirms recent evidence that jointly displaying Nutri-Score and Eco-Score would improve the NQI of food choices but not the environmental impact indicator (EII). The addition of personalised basket scores to the product scores or the addition of social norms to the product & basket scores norm did not lead to additional shifting behaviour as regards neither the nutritional quality nor the environmental impact. This study illustrates how smart interventions on the visibility and proximity of products with better Nutri- and or Eco-Scores in the food environment can still affect food choices, where more cognitively oriented nudges may fail. Once uniform labeling is in place, these effort-reducing strategies could be key to realising dietary transition.

Montagni I, Pouymayou A, Pereira E, Tzourio C, Schück S, Texier N, González-Caballero JL; CONFINS Group

Measuring Digital Vaccine Literacy: Development and Psychometric Assessment of the Digital Vaccine Literacy Scale

*J Med Internet Res* 2022 Dec 14;24(12):e39220. doi: 10.2196/39220

Social media have been defined as a powerful catalyst for the “anti-vax movement”. With the COVID-19 pandemic, the number of people seeking vaccine-related information on the internet has skyrocketed as well as the circulation of false information about vaccines on social media platforms. the spread of fake news. Misinformation on social media is blamed as a primary cause of vaccine hesitancy. But the Internet is also a source of official reliable information and might provide new instruments to fight against vaccine hesitancy. To reduce the anxiety of this duality and provide information on the way users understand, trust and appraise vaccine-related information, authors aimed at building a tool to measure a new literacy scale mixing digital health literacy and vaccine literacy, called “digital vaccine literacy” (DVL). The study described the development and psychometric properties of this new scale measuring DVL. A panel of five public health researchers proposed a series of items inspired by the Health Literacy Questionnaire, the eHealth Literacy Scale, and the Vaccine Literacy Scale. They identified a total of seven questions answered on a 4-point Likert scale (from 4 [agree] to 1 [disagree]) and an additional answer option “I do not know, I do not look for vaccine-related information.”: 1. I find vaccine-related information on social media and forums is understandable; 2. I find vaccine-related information on government websites is understandable; 3. I can detect vaccine-related fake news; 4. I trust vaccine-related information provided by government websites; 5. I find vaccine-related information on social networks is valid; 6. When I read vaccination information online, I cross-reference it with other sources to verify its validity; 7. I think the information I find online may influence my decision to get vaccinated A group of 10 volunteers with characteristics like the target population pretested the questions. The total score of the DVL scale was calculated through the sum of all answers to the items and varied from 7 to 28. The higher the score, the better the DVL level. DVL tool was administered to participants from an open online cohort, CONFINS, which is a cohort collecting data on the impact of confinement on the health and well-being of the French population. All participants were aged more than 18 years, living in France, and were able to read and understand French. The study sample contained

848 participants who responded to the items. 73.1% (620/848) were females. The mean age was 29.9 (SD 12.3). Participants working or studying in the field of health were 397/848 (46.8%). The percentage of parents was 20.9% (178/848) and 557/848 (65.7%) were not vaccinated against flu. The mean DVL score of the baseline sample of 848 participants was 19.5 (SD 2.8) with a range of 7-28. The median score was 20. Scores were significantly different by gender ( $P=.24$ ), age ( $P=.03$ ), studying or working in the field of health ( $P=.01$ ), and receiving regular seasonal flu shots ( $P=.01$ ). The first subdimension (items 2 and 4) refers to understanding and trusting official information about vaccination provided by institutional websites. The second subdimension (items 1 and 5) refers to understanding and trusting information about vaccines as provided by social media. The third subdimension (items 3, 6, and 7) refers to the appraisal of vaccine information online in terms of evaluation of the information and its application for decision-making. Having a low DVL score ( $<20$ ) can be interpreted as a relevant alarm in relation to the extensive use of the internet for vaccine-related content, especially in France. As is the case with health literacy, low DVL scores are associated with a higher risk of adopting unhealthy behavior; in this case, this refers to the decision not to get vaccinated. Not being able to navigate information on the internet could increase the chance of having a negative perception of vaccines. Lower scores in the scale would also correspond to the incapacity to recognize fake news and trust in unofficial information provided by social media. DVL scale is a screening instrument contributing to detect people who need to be supported in navigating vaccine-related information online.

**Gignac F, Righi V, Toran R, Errandonea LP, Ortiz R, Nieuwenhuijsen M, Creus J, Basagaña X, Balestrini M**

**Co-creating a local environmental epidemiology study: the case of citizen science for investigating air pollution and related health risks in Barcelona, Spain**

**Environ Health 2022 Jan 12;21(1):11. doi: 10.1186/s12940-021-00826-8**

The publication of new scientific evidence about the health risks of air pollution is contrib-

uting to raising public concerns. Researchers have started to incorporate participatory practices to better align the design of their studies on air pollution and health with public concerns, with the hopes that research results can then lead to actions relevant to the local community's needs. Over the last few years, although there have been several initiatives claiming to apply a citizen science approach to measure air quality parameters, participatory research projects on air quality are not new and exist since more than two decades. While such initiatives are driven by health-related concerns, those research projects for the study of air pollution using citizen science or other participatory approaches do not often focus specifically on assessing the link between air pollution and health. The authors adapted and developed a four-phase framework with features that occur in different participatory practices in environmental health research: (1) identification (civic concerns are identified and translated into a research question), (2) design (data collection tools, data governance and other aspects of the study protocol are defined), (3) the deployment (data are collected and analyzed) and (4) action (results are transformed into practical citizen produced knowledge to inform public policies). Following this co-created citizen science framework, the project aims to involve citizens in all phases of the research, including deciding the research question, designing the study, collecting and analyzing data, interpreting and disseminating the results and ultimately, suggesting policy-related actions. The pilot study was conducted in the city of Barcelona (Spain), which covers the topic of air pollution and health. The process of co-designing the research question was conducted from August 2019 to January 2020 and included (1) an online survey on knowledge, perceptions and preferences on topics to be investigated around the theme of air pollution and health, (2) a pop-up intervention to approach citizens and discuss their interests and concerns, (3) a community meeting with citizens in order to start formulating potential research questions based on the results of the survey, and (4) a second online survey to identify the most preferred research question to be implemented in the epidemiological study. The first survey was launched alongside a strategic video campaign entitled "Everything you wanted to know about the air but were

too afraid to ask". The invitation proposed the respondents to partake in the design of a scientific study, the first phase of which consisted of collecting citizen concerns and topics of interest regarding research on air pollution and health. An offline pop-up intervention across all the districts of Barcelona was also organized during the Parking Day, an annual initiative in which various organizations and communities temporarily transform public parking spaces by giving them a different use, one that promotes a sustainable urban environment. One stand was installed in ten districts of Barcelona and for each stand a canvas was developed for allowing for in-depth discussions. This canvas consisted of a poster with the title "What worries my neighbourhood regarding pollution and health?" listing different body parts and health topics. Citizens had to identify the one they would like to know how air pollution affects it using stickers and were asked to explain why. The final study protocol was written by the scientists considering all citizens' inputs, made available online and shared with a selected group of citizens for feedback. A total of 488 out of the 582 respondents were living in the ten districts of Barcelona City. Almost 65% of the respondents perceived the air as considerably polluted (37.50%) or highly polluted (27.46%). According to 488 respondents from the first survey, cognitive and mental health were the main priorities of investigation. From the answers of a total of 466 respondents describing the effects of air pollution on their health, a total of 192 keywords were counted, in which the most frequent health-related word reported referred to the respiratory system (312 times), to cardiovascular health (80 times) and to stress (75 times). Based on the second survey, with 27% of the votes from 556 citizens, the most popular research question was, "How does air pollution together with noise and green/blue spaces affect mental health?". The study design selected was an observational study in which citizens provide daily repeated measures of different cognitive and mental health outcomes and relate them to the air pollution concentrations. Based on the co-creation activities and the results obtained, the authors conclude that applying citizen science in an environmental health project is valuable for researchers despite some challenges such as engaging citizens and maximizing representativity.