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Spanish citizens' opinions on future trends in cardiology as expressed in digital ecosystems

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Patient-centred medicine is a healthcare approach that focuses on patients' wants, needs and preferences. An obstacle to implement patient-centred medicine is the difficulty of obtaining data that is relevant and representative of the whole society. In 2019, the Spanish Society of Cardiology highlighted eight trends that would exert a determining influence on the future of cardiology: "demographics", "economic environment", "political environment", "citizens' expectations", "incorporation of women", "technological innovation", "health levels and cardiovascular risk factors" and "healthcare organisation and management". In order to assess these trends from a pacient-centred approach, the aim of this study is to evaluate the opinions of the individuals who are part of Spanish society, regarding the eight trends identified by the Spanish Society of Cardiology, using natural language processing tools to analyse the communications expressed by citizens in digital ecosystems and official channels of communication. We analysed communications published between 2007 and 2019. Natural language processing identified 17 areas of opinion that support the eight trends. We evaluated the impact of each area of opinion based on the standard metrics of online reputation: presence, emotion and reach. Thus, 257,456 communications were analysed. The most relevant trend was "healthcare organisation and management" (54% of the total impact), followed by "health levels and cardiovascular risk factors" and "demographics" (14% and 10%, respectively). The least relevant trend was "citizens' expectations" (1%). Within the areas of opinion identified, the one with greatest impact was "the cardiologist" (16% of the total impact). In conclusion, the results of this research show that natural language processing tools are a useful tool for patient-centred medicine. The high impact associated with the cardiologist's role, together with the low impact observed for "citizen's expectations" show that Spanish citizens identify the cardiologist as the leading figure regarding their cardiovascular health.

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Introduction

Patient-centred healthcare has been defined as "healthcare that establishes a partnership among practitioners, patients and their families (when appropriate) to ensure that decisions respect the patients' wants, needs and preferences and that patients have the education and support they need to make decisions and participate in their own care" (Institute of Medicine (US) Committee on Quality of Health Care in America, 2001). The patient-based focus of medical practice has grown constantly since the second half of the 20th century (Groene, 2011). Over time, this concept, which was originally limited to areas associated with the optimal implementation of patients' rights and their empowerment at times of decision-making, has come to include a new dimension that includes the opinions, aspirations and needs of both the current and potential patients of healthcare systems (Groene, 2011). This now forms an essential component in the organisation of healthcare systems (Oben, 2020). In this context, it is of utmost importance to know the expectations that patients and citizens in general have about healthcare at its various levels from hospitals (Boyer et al., 2006) to government institutions (Hodgkin & Taylor, 2013) or health research groups and medical-scientific societies (Anguita Sánchez et al., 2019). However, there are many obstacles that prevent implementation of citizens' expectations (E. Davies & Cleary, 2005), one of the most outstanding of which is the difficulty of obtaining relevant information that is representative of a group as extensive as the whole society (Anguita Sánchez et al., 2019).

In recent years, social media have proven to be a highly useful tool, and some of their many applications are widely used in the sphere of medicine, both in clinical practice and in research, for the creation of working groups and the dissemination of information presented in magazines or at conferences and congresses (Parwani et al., 2019; Vidal-Perez et al., 2019). Besides this, social media also represent a space where citizens can leave their opinions, so these communities constitute a potential source of knowledge about society's expectations in the field of health. Modern day society is increasingly interconnected, and the public interact and express opinions about an immense variety of themes in digital ecosystems (Peláez et al., 2019). The term "digital ecosystems" referes to online means of communications, forums, websites, social media (like *Facebook* or *Twitter*), multimedia content creation platforms (such as *YouTube* or *Instagram*), online scienctific journals and online publications of the traditional general press.

The *Spanish Society of Cardiology*, known as *Sociedad Española de Cardiología* (SEC) in Spanish, is a scientific society whose main objectives are to promote the study, prevention, and treatment of cardiovascular diseases in Spain by supporting training, research and public education in this field of medicine. In agreement with its objectives, the SEC published an article in 2019 entitled "Cardiologists and the Cardiology of the Future". The article sets out the society's view of the role that cardiologists and this field of medicine should play, its situation to date, current trends and changes in the field, in addition to the needs and policy proposals based on the *Society's* research. In general terms, the article identifies eight change trends which will, in the SEC's opinion, influence the cardiology of the future: economic environment, political environment, demographics, health levels and cardiovascular risk factors, citizens' expectations, incorporation of women, technological innovation and healthcare organisation and management (Anguita Sánchez et al., 2019).

Knowledge of the opinions and emotions expressed by society in general about the main lines of work proposed by any organisation is of great importance as it allows integration of the target public's perspective and improves attainment of the intended objectives (de Las Heras-Pedrosa et al., 2020; Peláez et al., 2018). The objective of this paper is, therefore, to evaluate the opinions of the individuals who form Spanish society regarding the eight trends identified by the SEC. In order to do so, we used natural language processing (NLP) tools to analyse the opinions expressed by citizens in digital ecosystems and official channels of communication.

Methods

We obtained the written opinions of the public related to the future trends in cardiology identified by the SEC: economic environment, political environment, demographics, health levels and cardiovascular risk factors, citizens' expectations, incorporation of women, technological innovation and healthcare organisation and management (Anguita Sánchez et al., 2019). These opinions were acquired directly from the main means of communication in digital ecosystems: *Twitter*, *YouTube*, *Instagram*, official press websites and Internet forums. Determination of the universe of this study is a complex matter, given that the total population of Spain, according to the Spanish Institute of National Statistics, is 47,100,396 inhabitants (1 July 2019 estimate) (*Cifras de Población (CP) a 1 de julio de 2019. Estadística de Migraciones (EM). Primer semestre de 2019*, 2019). Regarding this population, current estimates suggest that 68% are internet users who, therefore, use social media and digital means of communication. Theoretically, each individual user of the Internet in Spain had the same probability of being included in our study. To overcome this difficulty, for our research, we considered communications that expressed unsolicited opinions that met the following criteria:

- The communication makes explicit reference to cardiology, cardiologists, medical-scientific societies related with cardiology in Spain or to the cardiology services of the Spanish Public Health System.
- The author of the communication is over the age of 18, as reported to the data services and sources, whenever this information was available.
- The communication is public and may be read without the need to subscribe to the information source or receive explicit permission from the issuer of the communication.
- The communication does not come from an advertising campaign.
- The communication has not been generated by an automated procedure or application (*bots* and *fake posts* among others).

The data compiled were published in the period between July, 1st 2007 and December, 31st 2019. In March 2007, the SEC published the study *Trends and contexts in European cardiology practice in the next 15 years. The Madrid Declaration: a report from the European Conference on the Future of Cardiology, Madrid, 2–3 June 2006*, which was preceded by a study of the resources, needs, and organisation of cardiology patient care (Escaned et al., 2007). This document has led the activity of the SEC since it was published. So, the initial of this work was 1 July 2007. The publication of the document *Cardiologists and the Cardiology of the Future in 2019* pointed the finalisation of this study, and the date of this end was established on 31 December 2019.

Identification of area of opinion using natural language processing analysis. An area of opinion is a set of communications related to a part or a section of a trend or experience (Peláez et al., 2019). The experience of a patient who receives healthcare or the

experience of a community who participates in an activity to promote health are examples of experiences in different areas. A trend may thus encompass one or several hierarchically related areas of opinion. In such a case, it is necessary to identify the areas of opinion close to each of the eight trends the SEC established. To do so, the compiled communications were anonymized, eliminating authorship data, location, source, images, hyperlinks, and non-textual components, to leave only the text corpus. This corpus of communications was analysed using the NLP tools provided by the IBM Watson Analytics service (Hoyt et al., 2016) and the Applied Social Research Centre of Malaga University (CISA). NLP analysis provided a taxonomy for areas of opinion.

Model for management and assessment of intangible assets. As previously indicated, the change trends in cardiology are represented in digital ecosystems as a set of communications, many of which express the emotions generated among the different members of the public to their experiences of healthcare systems, cardiology services, scientific and professional associations or societies, among others.

This and other types of relationships can be explained with the model for measurement and management of intangible assets GE2AN, shown in Fig. 1, which has already been applied in business, social and political sectors (*Approaching the Future—Ecosistema de Conocimiento de Corporate Excellence*, 2021; Pelaez et al., 2017; Peláez et al., 2019). GE2AN is a two-way management model that takes emotion as a central element, and can be used to track the management undertaken by an organisation until impact is produced in the organisation or to determine which management action has caused a specific impact on the organisation's business. In general, the model works as follows:

- The business undertakes a management action (for instance, a new process of patient care).
- This new management process generates experiences in the users through points of contact with patients (for instance, a new appointment system for patients or a Holter implantation protocol).
- The experiences generate emotions, which in turn generate an attitude towards the organisation that has impact on the organisation's business (for instance, recommending or visiting a cardiologist, hospital or using a hospital service).

Quantification of impact. The impact of each area of opinion is determined using a hybrid multi-criteria decision analysis (MCDA) model, supported by a series of standard online reputation metrics: presence, emotion and reach (Peláez et al., 2018) following the formula:

$$\text{Impact} = P \times \left[(\text{presence} \times 0.120) + (\text{emotion} \times 0.650) + (\text{reach} \times 0.230)\right]$$

where P represents the relative weight of the trend obtained using NLP, and the presence, emotion and reach take values between 0 and 1. We thus obtained an objective impact assessment in the form of a number between 0 and 1, where 0 represents the total absence of impact and 1 represents an impact equal to or greater than average (nominal impact).

Presence. Online presence is an Online Reputation Index (ORI) metric that answers the question of how much a specific theme has been spoken about. The online presence of each trend was quantified as the number of communications related to the trend, standardised with regards to the mean as the upper bound. If the number of communications of the trend is greater than or equal to the mean of all trends, online presence takes a value of 1; otherwise, online presence takes the value of the quotient of the division between the number of communications and the mean. Therefore, online presence always has a number between 0 and 1.

Emotion. Emotion is an ORI metric that represents the tone of sentiment that members of the public express in written form. Emotion takes a value between −1 and 1, where −1 implies a totally negative emotion, 0 implies a totally neutral emotion, and 1 is a totally positive emotion. Neutral emotions are related to official media publications, news or purely informative materials, whereas positive and negative emotions are the public's opinions and experiences (Karanik et al., 2019).

Reach. Reach is an ORI metric that represents the quantity of people who saw or interacted with the publications related with a trend. Each content platform has a value that represents the reach of the communications, for instance, retweets, shares, favourites, likes, stars, among others. In this case, the reach of a trend was determined by the sum of the highest individual reach values for each of the communications related to the trend.

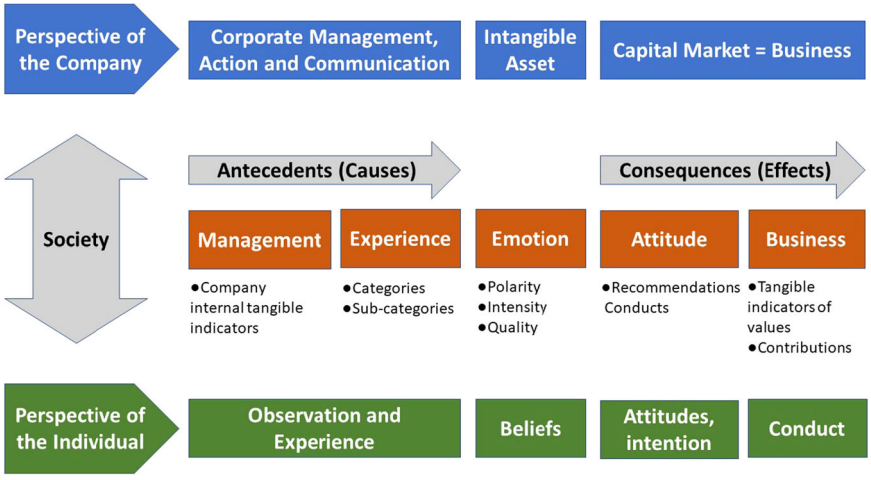

Fig. 1 Model for measurement and management of intangible assets GE2AN. Short description: the figure shows sa two-way management model that takes emotion as a central element, and can be used to determine which management action has caused a specific impact on the organisation's business.

Table 1 The impact of areas of opinion related to the most relevant trends for the future of cardiology identified by the Spanish Society of Cardiology.

Trend	Relative weight	Area of opinion	Presence	Emotion	Reach	Impact
Demographics	0.174	Ageing population	0.220	0.750	1.000	0.129
Economic environment	0.075	Management of resources	1.000	0.125	1.000	0.032
Political environment	0.035	Healthcare administrations	1.000	0.950	1.000	0.034
		Local initiatives	0.444	0.825	1.000	0.029
Citizens' expectations	0.047	Digitalisation and the information society	0.231	0.125	0.250	0.008
Incorporation of women	0.089	Measures to foster equality between professionals of both sexes	0.822	1.000	1.000	0.087
Technological innovation	0.076	Medical-scientific societies	1.000	0.350	1.000	0.044
		Scientific activities	1.000	0.200	0.850	0.034
		Technological change	0.611	0.250	0.100	0.020
Levels of health Cardiovascular risk factors	0.282	Fostering health & prevention of cardiovascular disease	1.000	0.425	1.000	0.177
Healthcare organisation and management	0.222	The cardiologist	1.000	1.000	0.775	0.211
		Institutional responsibility	0.165	0.650	0.900	0.144
		Nursing in cardiology	0.147	0.575	0.325	0.104
		Clinical management	0.951	0.225	0.450	0.081
		Integration with other healthcare services	0.196	0.275	0.425	0.067
		Self-government	0.312	0.100	0.450	0.046
		Healthcare environment	0.114	0.100	0.350	0.035

Presence was quantified as the number of communications related to the trend, standardised with regard to the mean as the upper bound.
Emotion represents the tone of sentiment expressed in written form. Emotion takes a value between −1 and 1, where −1 implies a totally negative emotion, 0 implies a totally neutral emotion, and 1 is a totally positive emotion.
Reach represents the quantity of people who saw or interacted with the publications related with a trend. The reach of a trend was determined by the sum of the highest individual reach values for each of the communications related with the trend.
Impact was determined using the following formula: Impact = $P \times [(\text{presence} \times 0.120) + (\text{emotion} \times 0.650) + (\text{reach} \times 0.230)]$: P represents the relative weight of the trend obtained using natural language processing tools.

Results

The NLP analysis identified a total of 257,456 communications for analysis. Segmentation of the period 2007–2019 by the total number of communications provided three clearly defined periods: 2007–2012 with 3% of communications, 2013–2015 with 28% of communications, and 2016–2019 with 69% of communications. The NLP analysis enabled identification of a taxonomy that included 16 areas of opinion associated with the eight SEC trends. These areas of opinion summarise the topics and key words that the public used to express their experiences and emotions about cardiology, cardiologists, the medical-scientific societies related to cardiology in Spain, and the cardiology services of the Spanish Public Health System.

Table 1 shows the areas of opinion related to each of the corresponding trends alongside the results of the impact calculations for each area of opinion. Regarding the taxonomy, it is noteworthy that five of the trends only related to one area of opinion, which contrasts with the trend "healthcare organisation and management" that is related to seven different areas of opinion. At the specific level of areas of opinion, the area with the greatest impact is "the cardiologist" with an evaluation of 0.211, which is equivalent to 16% of the impact compared to the other areas. Secondly, "fostering health and prevention of cardiovascular disease" is found at 0.177 (14%). "Institutional responsibility" comes thirdly with 0.144 (11%), followed in fourth place by "ageing population" with 0.129 (10%). Therefore, the first four positions of the ranking for area of opinion occupy more than half (51%) of the total impact of the sixteen identified areas.

Figure 2 provides a graphic illustration of the impact of the different areas of opinion. Cells of the same colour represent the areas of opinion that belong to the same trend. Cell size represents the impact detailed in Table 1. This illustration shows at a glance the differences between the impacts of the various trends, as well as how the areas of opinion contribute to their size.

Table 2 shows detail of the accumulated impact for each of the trends. Of the eight trends assessed, the study shows that all of them were represented in the communications analysed, although their impact was very different. The trend "healthcare organisation and management" holds a predominant position that is markedly higher than the others with 54% of the total impact for the trends studied; the next highest is "health levels and cardiovascular risk factors" with 14% and "demographics" with 10% of the impact. The trend"citizens' expectations" was the one that had the least impact (1%).

Discussion

The results of this research show that NLP tools are a useful tool for "patient-centred medicine". We assessed Spanish citizens' opinions on social media regarding a specific topic on cardiovascular health, as for the 8 different trends identified by the SEC. It stands out that the collected opinions were not asked for nor by the authors of this work (nor by members of the SEC) and were willingly emitted by people throughout a long interval of time (2007–2019).

The results of our research suggest that in Spain the public has reacted favourably to the trends for the future of cardiology identified by the SEC shown in Table 1. The main evidences for this are the positive values obtained in emotion in all areas of opinion, and the high values for reach expressed in many of the areas of opinion. In addition to this, there was a high number of communications related with the trends observed in the digital ecosystems, and a large quantitative increase in this type of communication, fundamentally in the 2016–2019 period. In all likelihood, the explanation for it is an increase in the use of the digital ecosystems by Spanish society.

The trend with greatest impact of the eight indicated by the SEC was "healthcare organisation and management". Within this trend, "the cardiologist" was the area of opinion that had the most impact (16% of the total impact), almost twice that of the other areas of the same trend that followed in second and third place respectively: "institutional responsibility" and "nursing in cardiology". This result is relevant because it shows

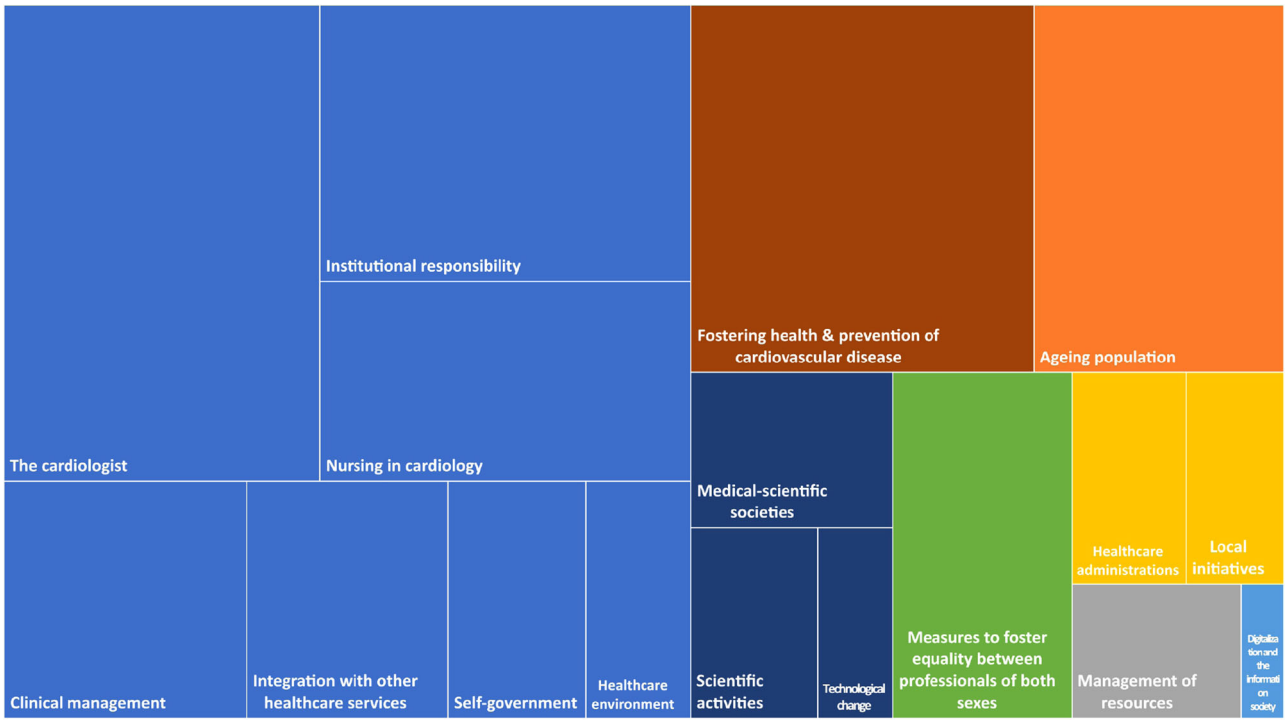

Fig. 2 Distribution of the impact of the different areas of opinion. Short description: this illustration shows at a glance the differences between the impacts of the various trends, as well as how the areas of opinion contribute to their size.

Table 2 Impact and accumulated impact of the most relevant trends for the future of cardiology identified by the Spanish Society of Cardiology.

Trend	Impact	Accumulated impact
Healthcare organisation and management	0.688	54%
Levels of health Cardiovascular risk factors	0.177	14%
Demographics	0.129	10%
Technological innovation	0.097	8%
Incorporation of women	0.087	7%
Political environment	0.063	5%
Economic environment	0.032	3%
Citizens' expectations	0.008	1%

that the users of digital ecosystems hold the figure of the cardiologist to be the most relevant element in the organisation and management of healthcare in the area of cardiology, ahead of other actors such as political figures or institutional managers. In addition, the high impact of the figure of the cardiologist is the first item of data that suggests what remains a deficient assimilation by Spanish society of patient-based medicine, at least as far as organisational aspects are concerned. This concurs with other research that has indicated the limited implementation of patient preferences in contemporary medical practice (Kim et al., 2020).

The trend with second-greatest impact was "health levels and cardiovascular risk factors". It is related to an only area of opinion called "fostering health and prevention of cardiovascular disease". The great impact observed in this area of opinion contrasts with the poor results that have systematically been observed in our country when it comes to the population's adherence to the recommendations formulated on cardiovascular risk factors (Kotseva et al., 2016, 2019). The results of a work on the PREDIMED's cohort stand out. The adherence to the Life's Simple 7 Strategies was evaluated; 4 health behaviours and 3 health risks were studied: low body mass index, not smoking, healthy diet and physical activity; cholesterol, blood pressure and fasting blood glucose. They were defined in 2010 by the American Heart Association and conceibed as a guide to prevent cardiovascular risk. The authors informed that the percentage of participants that respectively fulfilled 6 or 7 metrics was 0,25% or 0,05% (Díez-Espino et al., 2020). Therefore, the difference between the big impact on the area of opinion "fostering health and prevention of cardiovascular disease" and the low adherence to the recommendations and the objectives to cardiovascular prevention can be explained from several perspectives. Firstly, a major information exercise is probably needed so that the general population know the recommendations. Secondly, it is is necessary to identify the barriers that do not let the Spanish population take action on their own cardiovascular health prevention. It is also vital to rise the awareness on the importance of the achievement of the objectives and adopt policies that promote and facilitate healthy habits.

The trend "demographics" takes third place. This trend is limited to a single, specific area of opinion, "ageing population". Spain has one of the highest life expectancies in the world, with 86.7 years for women and 81.1 years for men in 2019 (*Productos y Servicios/ Publicaciones/Publicaciones de Descarga Gratuita*, 2022). This high life expectancy is a really positive result; however, Spanish society is concerned about concepts such as disease-free life expectancy, which has been reduced in the last years due to cronic diseases (Zueras & Rentería, 2020) . Therefore, a new challenge arises: getting a disease-free life expectancy as high as life expetancy currently is.

The remaining trends ("technological innovation", "incorporation of women", "political environment", "economic

environment" and "citizens' expectations") have low impact on digital ecosystems.

"Technological innovation" is an area with limited impact on the public's emotion, possibly because they consider that there are good technological and professional levels, or perhaps due to a limited confidence in the potential benefits that technological development can bring. Nonetheless, as opposed to this low impact, we can see that in the last years (even after 2019, that is, after the period assessed in this study) the use of wereables technological devices has extremely increased (Svennberg et al., 2022). These devices are often prescribed by the doctor; and in some other times self-indicated by the patients. All of the above shows that the low impact observed for "Technological innovation" has nothing to do with the rise that, in the next years will be seen for the new technologies that support cardiology. The indications, use and information offered to users on these devices should probably be improved so that the population have a better opinion on them.

"Incorporation of women" is related to gender equality in the area of cardiology, which the general public do not identify as a matter of concern, unlike the importance this issue has in other areas of society. Such low impact also contrasts with the enormous relevance currently given to the study of gender differences in practically all areas of cardiovascular diseases (de Marvao et al., 2021; Farrero et al., 2021; Minhas et al., 2021). It also diverges from the growing sensitivity that cardiovascular healthcare professionals show for the gender differences they observe in their careers in the majority of developed countries, where it is recognised that women have greater difficulties in terms of professional advancement (Blumenthal et al., 2017; Sambola et al., 2019).

The trends "political environment" and "economic environment" have relatively low importance, which highlights that the public focus most on their expectations related to cardiovascular health on the figure of the cardiologist. However, it is currently accepted that health and disease are mainly influenced by social determinants of health, that mainly depend on macroeconomic and social policies (Morteruel et al., 2020). Spanish population do not notice this fact.

Finally, it is interesting to note that the "citizens' expectations" trend, which revolves around the demand for more information, more ability to choose and decide, more immediacy and more convenience, has the least impact of the trends, which again and very directly indicates the low reach that patient-based medicine currently enjoys. This result suggests the need to improve the official information and communication strategies of both cardiology services and medical-scientific societies. Although recent years have seen a notable increase of communication between cardiovascular healthcare professionals, precisely related with the generalised use of social media (Davies, 2020; Ladeiras-Lopes et al., 2020; Walsh, 2018; Yeh, 2018), communication with the rest of society is still low, and requires greater interaction with the general population, similar to the strategies employed by other types of organisation such as major multinational companies (Peláez et al., 2018).

After analysing the opinions on the 8 future trends, we can observe that the implications for the future are diverse, as it has already been commented in the Discussion. Both healthcare cardiovascular professionals and healthcare and area political management staff can find several protocols of actions that will lead to actions that will have a positive impact on the whole society. This way, the first limitation of this work is that specific measures to improve were not analysed after the assessment of social media users. This could be an interesting line of interest for future works. On the other hand, it is important to highlight that one of this study's limitations resides in the sector of Spanish society that does not interact with digital ecosystems or does so only infrequently. This study of digital ecosystems confined itself to passive observation, and did not explicitly request opinions from the public. Future lines of research into the opinions of Spanish citizens about the areas reflected in this study should therefore include research that combines elicited information, using public opinion studies, with sample sizes that are significant at a national level, alongside unsolicited information that is extracted from digital ecosystems without formulating questions for the public. This type of study would allow us to discover both what members of the public say (public opinion studies) and what they do (digital ecosystems).

Conclusion

This study shows the analysis of Spanish citizens' opinions on social media regarding the 8 future trends of cardiology identified by the SEC. First of all, the results of this research show the factibility of the NLP tools to perform this kind of analysis that are oriented to know the healthcare system users' opinion, which is one of the key factors on patient-centred medicine. The high impact associated with the cardiologist's role, together with the low impact observed for "political environment", "economic environment" and "citizen's expectations" show that Spanish citizens identify the cardiologist as the leading figure regarding their cardiovascular health, above political and economical leaders and even above the citizens' own expectations. The great impact also related to the trend "health levels and cardiovascular risk factors" stresses the great importance that Spanish citizens give to the prevention of cardiovascular disease, from a theoretical perspective.

Data availability

The datasets generated during and/or analysed during the current study are not publicly available due to their complexity but are available from the corresponding author on reasonable request.

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Competing interests

The authors declare no competing interests.

Ethical approval

This paper did not need the approval of the Ethics Committee as it was not based on patients but on general anonymous population.

Informed consent

This research did not need a specific informed consent as it was not based on patients but on general anonymous population. In addition to this, we included a communication only when it was public and may be read without the need to subscribe to the information source or receive explicit permission from the issuer of the communication.

Additional information

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