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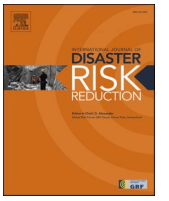

Social profiles and response patterns during the 2025 Iberian Peninsula power outage. The case of Spain

Raquel González-Pozo [a,b,*]

[a] IMUVA, PRESAD Research Group, MECOCISO Research Group, Departamento de Economía Aplicada, Universidad de Valladolid, Spain
[b] Facultad de Ciencias Sociales, Jurídicas y de la Comunicación, Universidad de Valladolid, Spain

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ABSTRACT

On April 28, 2025, a large-scale power outage disrupted essential services across Spain, Portugal, Andorra, and parts of southern France, leaving more than 50 million people without electricity. The event affected critical infrastructures such as transportation, telecommunications, and healthcare, raising concerns about the population's resilience in the face of unexpected crises. This study focuses on the case of Spain, using data from a representative flash survey conducted after the power outage, and analyzes the population's response with statistical techniques for categorical data, specifically multiple correspondence analysis (MCA). The analysis focuses on three main aspects: emotional impact (fear), material preparedness (emergency kit), and access to information. The results reveal marked differences among social groups. Young adults, women, and the unemployed reported greater emotional vulnerability, while older and inactive individuals were less emotionally affected. Preparedness was also unevenly distributed, with individuals with higher education more likely to be prepared. Regarding access to information, the data show a stronger association between middle-aged individuals, lower emotional impact, and the perception of having received sufficient information during the power outage. By identifying distinct response patterns, the study contributes to a better understanding of the social dimensions of crisis management and complements the existing literature on disasters and unexpected situations.

1. Introduction

On April 28, 2025, a large-scale power outage left more than 50 million people in Spain, Portugal, Andorra, and southern France without electricity. In a matter of seconds, the disconnection of 15 GW of electricity generation caused a widespread collapse of the power grid. This paralyzed essential services such as transportation, telecommunications, and healthcare services. Although full restoration was achieved in the early hours of the following day, the event revived concerns about the fragility of electrical infrastructures, even in highly developed countries. This case was not an isolated incident, as Europe has faced several large-scale blackouts in recent decades. In 2003, a failure in a Swiss transmission line left all of Italy in the dark [1]. Three years later, a disruption in Germany affected more than 15 million people [2]. More recently, in 2024, countries in southeastern Europe, including Bosnia, Montenegro, and Croatia, suffered similar widespread power outages [3]. Nevertheless, the 2025 event stands out as one of the largest blackouts in the Iberian Peninsula in recent decades and provides a unique opportunity to analyze social responses in Spain.

* IMUVA, PRESAD Research Group, MECOCISO Research Group, Departamento de Economía Aplicada, Universidad de Valladolid, Spain
E-mail address: raquel.gonzalez.pozo@uva.es.

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Beyond the technical aspects and economic costs such as communication breakdowns, loss of working hours, or the interruption of financial services [4], power outages also have significant social consequences, including increased psychological distress and a rise in medical emergencies [5]. Several studies have addressed these disparities from different perspectives. For instance, Rubin and Rogers [6] provided a comprehensive review of behavioral and psychological responses to power outages, highlighting patterns of preparedness, emotional impact, information-seeking, and vulnerability. From an anthropological approach, Özden-Schilling [7] studied how communities in Turkey and Texas experienced energy insecurity during blackouts. Moreover, it is also relevant to consider the role of public policies in managing power outage situations. In this regard, Yu et al. [8] showed that public acceptance of blackout policies depends on how they are designed and communicated.

Although large-scale power outages such as the one that occurred in the Iberian Peninsula in April 2025 are relatively rare, it is important to understand how citizens respond to such events to improve future crisis management strategies. For this reason, this paper aims to analyze the social response of citizens and provide a structured picture of how different affected groups experienced the blackout, based on multiple correspondence analysis (MCA). To do so, it uses data from a representative survey conducted shortly after the event. Given that the survey data are categorical, the MCA procedure is especially appropriate, since it allows a simultaneous analysis of multiple categorical variables through a clear visual representation that, in our case, facilitates the identification of social profiles. In addition, this approach reveals multidimensional response patterns that often remain hidden in regression models focused on a single outcome, or in spatial analyses limited to geographic units [9,10]. In this way, this paper provides new findings on social responses to a large-scale power outage in Spain that complement and enrich prior studies.

The remainder of the paper is organized as follows: Section 2 reviews previous research on large-scale power outages, highlighting social and economic impacts and identifying the research gap addressed by this study. Section 3 presents the dataset, methodology, and main results. Section 4 discusses the findings based on three key dimensions of social response: emotional impact, material preparedness, and access to information. Finally, Section 5 summarizes the main conclusions, presents some limitations of the study, and includes some suggestions for future research.

2. Impact, risk, and social response to large-scale power outages

In recent decades, large-scale power outages have been analyzed for their overall economic and social impact. These events can expose significant individual and collective vulnerabilities, especially when they affect millions of people simultaneously and without warning. Their effects have been addressed by several studies over the last years.

One of the most well-known cases is the August 2003 power outage in the United States and Canada, which left more than 50 million people without electricity. During that event, a wide range of social responses was observed, from acts of solidarity and community support to episodes of panic and stress [11]. Medical emergencies also increased significantly, particularly among older adults. In this regard, the work of Greenwald et al. [5] reported a high number of elderly patients who presented to emergency departments during the event. The power failure disrupted thousands of networks and significantly affected Internet connectivity, as noted by McGrath [12], leading to a loss of communication and access to information that generated uncertainty and a sense of vulnerability among the population. More recently, Flores et al. [13] analyzed the 2021 Texas Power Crisis and found marked geographic and social inequalities across counties, with Hispanic communities more likely to endure prolonged outages and medically vulnerable individuals facing disproportionate risks.

In the European context, episodes such as the 2003 blackout in Italy also highlighted the fragility of critical infrastructures and the cascading effects they can have on society. That event, which left almost the entire country without electricity for several hours, disrupted transportation systems, communications, and essential services. It also revealed once again the systemic risks associated with large-scale power failures [1]. Other significant power outages in Europe have also revealed systemic vulnerabilities. The 2006 European blackout, caused by a grid failure in Germany, left more than 15 million households in several countries without electricity for approximately two hours [14]. Subsequent analyses highlighted how this event exposed weaknesses in the coordination of interconnected transmission networks across Europe and the need for preventive measures to strengthen grid stability [15]. More recently, in 2024, a major incident in the southeastern European power grid disrupted the electricity supply for several hours in Bosnia and Herzegovina, Albania, Montenegro, and parts of Croatia, causing chaos and confusion in daily activities [3].

Apart from the material and human costs that such events can entail, several studies have shown that power outages can significantly affect both behavior and psychological well-being. As pointed out by Rubin and Rogers [6], the main effects include the disruption of daily routines (such as the search for warmth, food, and alternative means of communication), increased stress due to limited information, and a greater need for social contact. Loss of communication has also been identified as a fundamental element that directly contributes to increasing people's vulnerability during blackouts [16,17]. In this regard, recent research has emphasized the importance of identifying the population groups most exposed to such events. For instance, Rudolph-Cleff et al. [10] identified several highly vulnerable profiles in blackout scenarios in the city of Darmstadt, based on a contextual and geospatial analysis. These groups include people over 65, foreign nationals, individuals with low socioeconomic status, and households with children. Cutter [18] provided a retrospective overview of the concept of social vulnerability and the development of the Social Vulnerability Index (SoVI), analyzing its theoretical evolution and practical application in the field of disasters. Dugan et al. [19] proposed a social vulnerability index for long-duration power outages in Colorado. The index is built using principal component analysis (PCA) and is structured around three dimensions: health, preparedness, and evacuation.

However, not all consequences are negative. Emergency situations also reveal instances of community solidarity and support among neighbors. Previous studies have documented the benefits of local interconnectedness during power outages, including people helping their neighbors, checking on elderly relatives, or trusting others to collect essential supplies from local stores without

immediate payment [20,6,21]. Moreover, such events can drive the development of innovative emergency communication strategies, particularly when digital channels fail. A recent example is the proposal to use urban advertising billboards as physical platforms for disseminating urgent messages during long-lasting power outages [10].

The present paper examines social vulnerability and crisis management during prolonged power outages in Spain, a context that has received little attention in the literature. Unlike the United States, Canada, or Germany—where such events have been widely studied—the lack of long-duration blackouts in recent decades has limited research in the Spanish case. The April 2025 blackout in the Iberian Peninsula therefore offers a unique opportunity to analyze citizens' profiles, response capacity, and the factors influencing their preparedness and access to information. For this purpose, MCA and other statistical techniques are used to identify patterns of vulnerability and social response.

3. Methodology

3.1. Data

The analysis is based on data from the *Flash Survey on the Power Outage of April 28* (Survey No. 3513), conducted by the Spanish Centre for Sociological Research (CIS, in Spanish). The survey was carried out between April 29 and 30, 2025, and was addressed to people aged 18 and over residing in peninsular Spain. A total of 1,752 interviews were conducted using computer-assisted telephone interviewing (CATI), with 28.3 % of the interviews carried out via landline and 71.7 % via mobile phone.

According to the technical specifications of the survey, the sampling was stratified following the intersection of Spain's 15 autonomous communities (excluding the Balearic Islands, Canary Islands, Ceuta, and Melilla) and seven categories of municipality size, ranging from areas with fewer than 2,000 inhabitants to those with more than 1,000,000. Within each stratum, telephone numbers were randomly selected, and quotas based on sex and age were applied to ensure demographic balance. The final sample covered 668 municipalities across 47 provinces.

The survey includes sampling weights, which were applied for appropriate analysis at the aggregate level. The sampling error is estimated at ±2.4 % for the total sample, assuming simple random sampling and a confidence level of 95.5 %.

3.2. Variables and statistical analysis

The statistical analysis in this paper followed a stepwise approach, beginning with chi-square tests to identify significant bivariate associations, followed by MCA to uncover underlying multivariate patterns. The original questionnaire included several questions related to the power outage, but for the purpose of analytical clarity and to avoid redundancies due to high correlations between items, we selected three key variables that capture essential dimensions of the event: emotional response, individual preparedness, and access to information. To enable a profile-based analysis, the main variables were complemented with sociodemographic variables (age, gender, employment status, and educational level), which are widely used in similar studies [22,23]. Although income and social class are often considered relevant variables, they were not included because the CIS questionnaire did not allow for their precise measurement, and they did not show a clear relationship with the dimensions analyzed in the study.

Table 1 describes the variables included in the analysis, and Table 2 contains the frequency distribution of their response categories.

All selected variables are categorical, which makes MCA an appropriate technique for identifying patterns of association and visualizing latent relationships among categories. Before applying MCA, however, a series of chi-square tests was conducted to examine the associations between power outage–related variables and sociodemographic characteristics (see Tables 3 and 4).

The MCA procedure does not require specifying a dependent variable, which is consistent with the exploratory aim of this study. Neither cluster analysis nor latent class analysis was applied, since the purpose was not to classify respondents into a fixed number of groups but rather to uncover the underlying structure of associations among categories. For this reason, MCA provides an appropriate framework for exploring associations across variables. This multidimensional procedure reduces the dimensionality of the dataset by projecting the categories of all variables into a shared factorial space, where the proximity between points indicates a similar response pattern among individuals. The analysis was carried out using the *FactoMineR* and *factoextra* packages in R. The number of dimensions retained was determined based on the distribution of eigenvalues and the cumulative percentage of explained inertia. To represent the results and facilitate their interpretation, different plots were generated to show the categories of the variables included in the analysis. These visualizations are particularly useful, as they illustrate groupings among categories and help distinguish respondent profiles.

Table 1
Description of variables included in the analysis.

Variable	Description	Categories
FEAR	Whether the respondent felt fear during the power outage	A lot–Quite a lot/A little–Not at all
KIT	Whether the respondent had an emergency kit at home (e.g., water, food, medicines)	Already had it/Got it on the 28th
INFO	Whether the respondent received information during the power outage	Sufficient/Insufficient
SEX	Respondent's gender	Male/Female
AGE	Respondent's age group (recoded into four categories)	18–34/35–54/55–74/75+
EMPLOYMENT	Current employment status of the respondent	Active/Inactive/Unemployed
EDUCATION	Highest level of education attained	Primary/Secondary/Tertiary

Table 2
Frequency distribution of variables.

Variable	Category	Frequency	Percentage (%)
FEAR	A lot–Quite a lot	412	23.5
	A little–Not at all	1,340	76.5
KIT	Already had it	900	51.4
	Got it on the 28th	852	48.6
INFO	Sufficient	561	32.0
	Insufficient	1,191	68.0
SEX	Female	886	50.6
	Male	866	49.4
AGE	18–34	335	19.1
	35–54	709	40.5
	55–74	573	32.7
	75+	135	7.7
EMPLOYMENT	Active	1,112	63.5
	Inactive	497	28.4
	Unemployed	143	8.2
EDUCATION	Primary	74	4.2
	Secondary	770	43.9
	Tertiary	908	51.8

Table 3
Chi-square test results and Cramer's V values between blackout variables and sociodemographic characteristics.

Power outage variable	Sociodemographic variable	p-value	Significance	Cramer's V
FEAR	SEX	2.7e-15	***	0.293
	AGE	1.9e-05	***	0.218
	EMPLOYMENT	0.0032	**	0.081
	EDUCATION	0.0043	**	0.079
KIT	SEX	0.1419	n.s.	–
	AGE	1.8e-15	***	0.238
	EMPLOYMENT	1.1e-07	***	0.060
	EDUCATION	0.1185	n.s.	–
INFO	SEX	0.4863	n.s.	–
	AGE	0.0071	**	0.049
	EMPLOYMENT	0.2651	n.s.	–
	EDUCATION	0.1282	n.s.	–

$p < 0.05$ (*); $p < 0.01$ (**); $p < 0.001$ (***); n.s. = not significant. Effect sizes are reported as Cramer's V. – = not applicable because the result was not statistically significant.

Table 4
Chi-square test results and Cramer's V values between power outage variables.

Variable 1	Variable 2	p-value	Significance	Cramer's V
FEAR	KIT	5.3e-05	***	0.096
	INFO	1.1e-06	***	0.216
KIT	INFO	0.0114	*	0.060

$p < 0.05$ (*); $p < 0.01$ (**); $p < 0.001$ (***); n.s. = not significant. Effect sizes are reported as Cramer's V. – = not applicable because the result was not statistically significant.

3.3. Results

The results of the chi-square tests show several significant associations between the variables related to the blackout and the sociodemographic characteristics (Table 3). In particular, the experience of fear during the power outage is significantly associated with all the sociodemographic variables considered. In contrast, having an emergency kit at home is significantly associated with age and employment status, but not with sex or educational level. Regarding access to information, a significant association was observed only with age. However, not all associations have the same substantive importance. In the results, the relationship between fear and sex (Cramer's $V = 0.293$) and between fear and age ($V = 0.218$) reached a moderate association, whereas the remaining relationships (e.g., employment and education) were weak ($V < 0.10$).

With respect to the relationships among the three main variables related to the power outage (Table 4), all the chi-square tests results were statistically significant. This indicates that emotional response, preparedness, and access to information are interrelated dimensions of the event. Considering the values of Cramer's V, the results show a moderate association between fear and access to information ($V = 0.216$), while the relationships between the rest of the variables were weak ($V < 0.10$).

Table 5 shows the eigenvalues and the percentage of variance explained by each of the eleven dimensions extracted through MCA. The first three dimensions were retained for analysis and interpretation, as they together account for 39.8 % of the total variance. Although this percentage may appear low, it is quite common in social science research using MCA, where the complexity and multidimensionality of the data often result in relatively low variance explained per dimension [24–26]. This may be considered a limitation, but it does not compromise the robustness of the analysis, since in MCA the critical aspect is the interpretability of the retained axes, and in this study the three dimensions clearly capture consistent and meaningful social response patterns.

Table 6 presents the coordinates, the quality of representation (cos^2), and the total contribution of each category in the space defined by the first three dimensions of the MCA. For the interpretation, we considered both the contribution and the quality of representation (cos^2) to identify the most relevant categories in structuring the factorial space.

Categories related to age and employment status stand out, particularly "75+" (31.9 %), "Inactive" (27.0 %), and "Unemployed" (33.3 %), all of which show adequate representation ($cos^2 > 0.43$), highlighting their key role in structuring the factorial space. Regarding education level, "Primary" (24.6 %) also shows a notable contribution and acceptable representation. The emotional component, reflected in "A lot–Quite a lot" (25.1 %), highlights the differentiation of respondent profiles. In contrast, gender contributes to a lesser extent (approximately 12 %) and shows only moderate representation ($cos^2 = 0.332$), which may indicate a more limited influence of this variable in the composition of the factorial space.

Based on the results contained in Table 6, the three retained dimensions can be interpreted as follows. Dimension 1 represents a demographic–emotional axis, contrasting young, unemployed, and fearful respondents with older and inactive individuals with lower levels of education. Dimension 2 can be interpreted as an emotional intensity–preparedness axis, differentiating respondents who reported high levels of fear from those who displayed more control and material readiness (e.g., having an emergency kit). Dimension 3 mainly reflects an information and employment axis, separating younger unemployed respondents from older and less active ones, while also capturing differences in the perception of information received.

These patterns are visually summarized in the correspondence plot, or perceptual map, shown in Fig. 1, which represents the distribution of categories in the factorial space defined by dimensions 1 and 2, which together explain 29.2 % of the total inertia. This plot shows significant groupings that allow us to identify different profiles of citizens according to their experience during the power outage.

In the upper left quadrant, a profile emerges composed of young individuals (18–34 years old), unemployed, and women who reported high levels of fear. These categories are also close to those who already had an emergency kit and those with higher education. This shows a more emotionally affected profile, although with a certain degree of preparedness and a higher level of education.

In the lower right quadrant, categories such as men, people aged 55–74, those with secondary education, and individuals who reported having received sufficient information and little or no fear are grouped together. This group shows a more contained profile, with a less emotional reaction, a more positive perception of the information received, and a more pragmatic response. Moreover, in this area, there are also those who obtained the emergency kit on the same day as the power outage, which suggests a reactive but effective attitude to the situation.

On the other hand, individuals aged 75 or older, with a low educational level and inactive status, appear far from the rest of the categories. This indicates a more structurally disconnected profile, without a clear emotional response or an active role during the event.

These results are supported by the correspondence plots in Figure A1 and Figure A2 in the Appendix, which also incorporate dimension 3. In the plot of dimensions 1 and 3 (Figure A1), the upper quadrants are associated with younger and unemployed respondents, while the lower quadrants show older inactive individuals with lower educational levels. The plot of dimensions 2 and 3 (Figure A2) shows a similar pattern: the upper quadrants include respondents with stronger emotional reactions, whereas the lower quadrants group those with a calmer response, such as perceiving the information as sufficient or obtaining an emergency kit on the day of the power outage.

4. Discussion

This section discusses the main findings in relation to the three key variables analyzed in this study to understand citizens'

Table 5
Variance explained by each dimension in the MCA.

Dimension	Eigenvalue	Variance (%)	Cumulative variance (%)
Dim.1	0.2640	16.804	16.804
Dim.2	0.1925	12.253	29.057
Dim.3	0.1691	10.761	39.818
Dim.4	0.1508	9.597	49.415
Dim.5	0.1410	8.977	58.392
Dim.6	0.1345	8.563	66.955
Dim.7	0.1290	8.213	75.168
Dim.8	0.1217	7.745	82.913
Dim.9	0.1101	7.008	89.921
Dim.10	0.1024	6.517	96.438
Dim.11	0.0558	3.562	100.000

Table 6
Coordinates, quality of representation, and contributions of categories in MCA.

Category	Dim 1 Coord	Dim 2 Coord	Dim 3 Coord	Total quality (cos^2)	Total contribution (%)
A little–Not at all	0.121	−0.353	−0.031	0.456	7.731
A lot–Quite a lot	−0.395	1.147	0.099	0.456	25.145
Already had it	−0.333	0.357	0.042	0.253	8.000
Got it on the 28th	0.352	−0.377	−0.044	0.253	8.451
Insufficient	−0.125	0.202	−0.048	0.125	2.763
Sufficient	0.266	−0.429	0.102	0.125	5.866
Female	0.073	0.563	0.052	0.332	12.140
Male	−0.075	−0.576	−0.053	0.332	12.421
18–34	−0.437	0.449	0.975	0.317	20.177
35–54	−0.676	−0.070	−0.525	0.502	19.583
55–74	0.569	−0.373	0.329	0.277	12.083
75+	2.223	0.837	−1.057	0.564	31.883
Primary	2.100	1.825	−1.073	0.392	24.623
Secondary	0.169	−0.310	0.666	0.445	20.252
Tertiary	−0.314	0.114	−0.477	0.365	13.224
Active	−0.545	−0.168	−0.266	0.688	15.306
Inactive	1.313	0.165	−0.002	0.694	27.041
Unemployed	−0.326	0.729	2.073	0.439	33.309

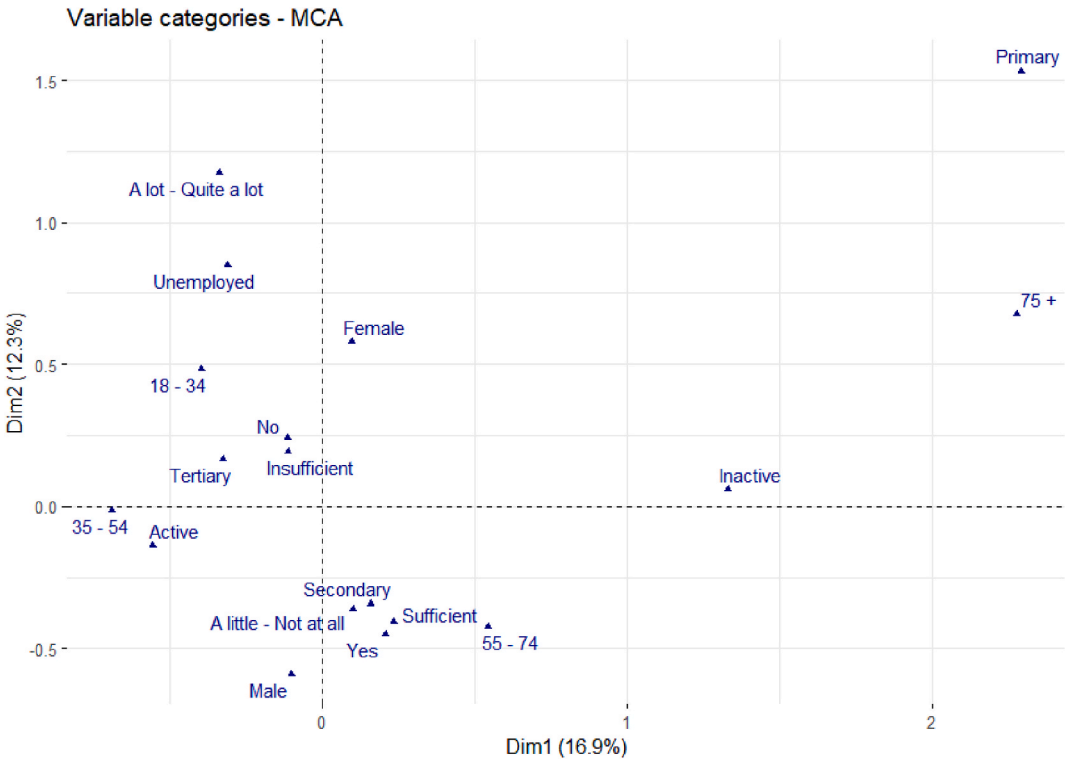

Fig. 1. Two-dimensional correspondence plot using MCA (dimensions 1 and 2).

responses to the power outage: emotional impact (fear), material preparedness (emergency kit), and access to information. Given the exploratory nature of MCA, the following interpretations should be understood as patterns of association rather than confirmatory evidence. The results highlight meaningful tendencies across sociodemographic groups, but causal explanations cannot be established. It is also important to acknowledge some limitations: the survey was conducted immediately after the event, which may have amplified emotional responses; all measures are self-reported and therefore subject to potential recall or social desirability biases.

4.1. Emotional impact

The experience of fear during an unexpected power outage is a key emotional response. The results show that young people (aged 18–34) and unemployed individuals reported higher levels of fear. A moderate effect size was observed for age (V = 0.22), whereas the

associations with employment status and education were weak ($V < 0.10$). Previous studies indicated that the stronger association among younger respondents may be linked to their reliance on mobile technologies and digital connectivity [27,28], as the failure of communication infrastructure during disasters is recognized as a major source of stress [6].

On the other hand, the existing literature reveals that older adults may be especially vulnerable during power outages due to medical needs, mobility limitations, or reliance on external services [5,29,30]. In contrast, the MCA results show that individuals aged 75 or older, as well as those classified as inactive or with only primary education, were positioned further away from other categories in the factorial space, indicating a less pronounced emotional response to the event. This finding is consistent with MacLeod et al. [31], who highlighted that older age groups may reflect greater emotional resilience developed through past experiences with disasters and life challenges. At the same time, other factors may also contribute to this pattern, including limited exposure to digital information channels, lower confidence in the ability of institutions to respond effectively, or even a sense of resignation in the face of recurrent crises such as public health emergencies, natural disasters, or power outages [32,33].

In addition, our results reveal behavioral differences according to gender. This pattern was evident both in the MCA map and in the chi-square analysis, which showed statistically significant differences between men and women (see Table 3 and Appendix Table A1). Fear associated with the power outage was higher among women than among men, with a moderate effect size ($V = 0.29$). These results support the finding that women reported higher levels of fear and are consistent with recent literature highlighting gender-based disparities in disaster responses [34,35,36].

4.2. Material preparedness

Material preparedness in the event of a power outage represents another fundamental aspect of citizen response. In our analysis, descriptive results show that 51.4 % of respondents already had a basic emergency kit before the outage occurred (see Table 2). This finding reflects compliance with recommendations promoted by institutions such as the European Union, which encourage citizens to be equipped for prolonged supply disruptions [37]. Similarly, previous research highlights that individuals and families often perceive themselves as primarily responsible for their own emergency preparedness [38].

Regarding the contents of this kit, Rubin and Rogers [6] emphasized the importance of including water, non-perishable food, a flashlight, batteries, medicines, and a radio. In our results, individuals aged 18–34 stood out among those who already had this type of kit at home. This pattern is in line with previous research highlighting the role of digital communication in shaping preparedness behaviors, as emergency campaigns disseminated through social media are often adapted to visual and easily shareable formats [39, 40]. By contrast, the MCA map shows a stronger association between the 55–74 age group and the purchase of the emergency kit on the day of the blackout. While earlier studies suggested that middle-aged adults are usually better prepared for such events [41], our findings show a different pattern of behavior during the blackout, since many individuals in this age group acquired an emergency kit on the day of the event.

From a gender perspective, the literature has shown that women are more vulnerable in emergency situations and crisis contexts [42,43–45]. At the same time, Ashraf and Azad [46] emphasized that the practical knowledge and experience of many women at the household and community level can be essential for emergency planning and management. Our analysis is consistent with these findings, as the MCA factor map shows a stronger association between women and the fact that they already had an emergency kit before the power outage.

Educational level is also associated with disaster preparedness in the event of a power outage. Studies such as Rashid et al. [47] and Torani et al. [48] reported that higher education is positively related to emergency readiness. This pattern is reflected in our findings, as the MCA factor map shows a stronger association between individuals with tertiary education and those who already had an emergency kit before the blackout.

4.3. Access to information

Regarding access to information, young individuals (aged 18–34) with tertiary education and who already had an emergency kit before the power outage were more likely to consider the information received as insufficient, while the group that reported having received sufficient information mainly included individuals aged 55–74 with secondary education. This latter group acquired the kit on the same day and expressed low levels of fear. The chi-square analysis confirmed that these differences were statistically significant (see Table 4), with a moderate effect size for the relationship between fear and access to information ($V = 0.21$) and weaker associations for preparedness ($V = 0.06$). These results are in line with previous studies showing that individuals with higher education and better preparedness often demand greater clarity, speed, or reliability in the information provided, whereas less prepared individuals may perceive even basic information as sufficient [49,17,50].

On the other hand, the power outage in Spain affected not only the electricity supply but also telecommunications infrastructure. Internet access was disrupted in many areas, and for several hours radio was practically the only available source of information across large parts of the country. This context is particularly relevant for young adults, who are accustomed to using social media platforms such as Twitter [51] and Facebook [52] as their primary source of real-time information. Previous studies have shown that interruptions to these digital channels often reduce satisfaction with crisis communication, which is consistent with our finding that young adults perceived the information provided during the blackout as insufficient. By contrast, older adults—regular users of traditional media [53,54]—were less affected by the disruption and were more likely to report that the available information was sufficient during the power outage.

5. Conclusions

This paper analyzed citizens' responses to the large-scale power outage that affected the Iberian Peninsula on April 28, 2025, using data from a flash survey and applying MCA. The main contribution of this study is that it provides new findings on social responses to a large-scale power outage in Spain. While previous literature has largely focused on cases in North America and Northern Europe, this work expands the geographic scope and demonstrates the usefulness of MCA for capturing multidimensional patterns of vulnerability. Thus, our results complement and enrich the literature on disasters and vulnerability [55,6,18].

The analysis focused on three dimensions: emotional impact, material preparedness, and access to information and showed how these were shaped by sociodemographic differences. Younger respondents, women, and unemployed individuals exhibited stronger emotional reactions, whereas older and inactive individuals reported lower levels of emotional involvement. Preparedness was also uneven: young adults and those with higher education were more likely to already have an emergency kit, while middle-aged adults were more associated with acquiring one during the blackout. Likewise, perceptions of the adequacy of information varied by age and education, with respondents with higher education more often judging the information received as insufficient.

In general, the results show that sociodemographic heterogeneity must be considered when designing crisis management strategies. It cannot be assumed that the population behaves uniformly or has equal access to resources. For this reason, public policies and communication channels should be tailored to the characteristics and expectations of different groups, with special attention to the most vulnerable [8,10,19]. In practical terms, this means that preparedness campaigns could be specifically designed for unemployed individuals and households with lower education levels, offering clear and accessible guidance on how to assemble basic emergency kits. In addition, communication strategies should be adapted to different age groups: while young adults may require rapid and reliable information through digital platforms, older adults may be better reached through traditional media such as radio or television.

Finally, this study has certain limitations. The data were collected through a flash survey conducted in the days immediately following the event. This early data collection provides valuable insight into immediate public reactions to the crisis, but some responses may have been influenced by self-reporting bias. Unfortunately, the questionnaire had a limited scope, as it did not include variables on other aspects such as social networks or health requirements. Nevertheless, the available data allowed us to focus on three variables that are highly important in the context of unexpected situations or disasters: fear, emergency kit, and access to information.

For future research, it is important to note that the MCA approach enables the identification of latent patterns among variables, but it does not allow for the establishment of causal relationships. Therefore, subsequent work may apply other procedures and techniques such as structural equation modeling or longitudinal designs to examine changes in perceptions over time. Additionally, future studies could focus on specific sociodemographic dimensions not addressed in this paper, for example the role of social networks during emergency situations and how these may contribute to preparedness.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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APPENDIX

Table A1
Cross-tabulations corresponding to significant associations (from Tables 3 and 4).

Fear vs Sex		Female		Male
A little–Not at all		607		733
A lot–Quite a lot		279		133
Fear vs Age	18–34	35–54	55–74	75 +
A little–Not at all	230	530	467	113
A lot–Quite a lot	105	179	106	22
Fear vs Employment	Active	Inactive	Unemployed	
A little–Not at all	837	404	99	

(*continued on next page*)

Table A1 (*continued*)

A lot–Quite a lot	275	93	44	
Fear vs Education	Primary	Secondary	Tertiary	
A little–Not at all	54	618	668	
A lot–Quite a lot	20	152	240	
Kit vs Age	18–34	35–54	55–74	75 +
Already had it	214	405	236	45
Got it on the 28th	121	304	337	90
Kit vs Employment	Active	Inactive	Unemployed	
Already had it	617	202	81	
Got it on the 28th	495	295	62	
Info vs Age	18–34	35–54	55–74	75 +
Insufficient	239	504	363	85
Sufficient	96	205	210	50
Fear vs Kit	Already had it	Got it on the 28th		
A little–Not at all	652	688		
A lot–Quite a lot	248	164		
Fear vs Info	Insufficient	Sufficient		
A little–Not at all	870	470		
A lot–Quite a lot	321	91		
Kit vs Age	Insufficient	Sufficient		
Already had it	637	263		
Got it on the 28th	554	298		

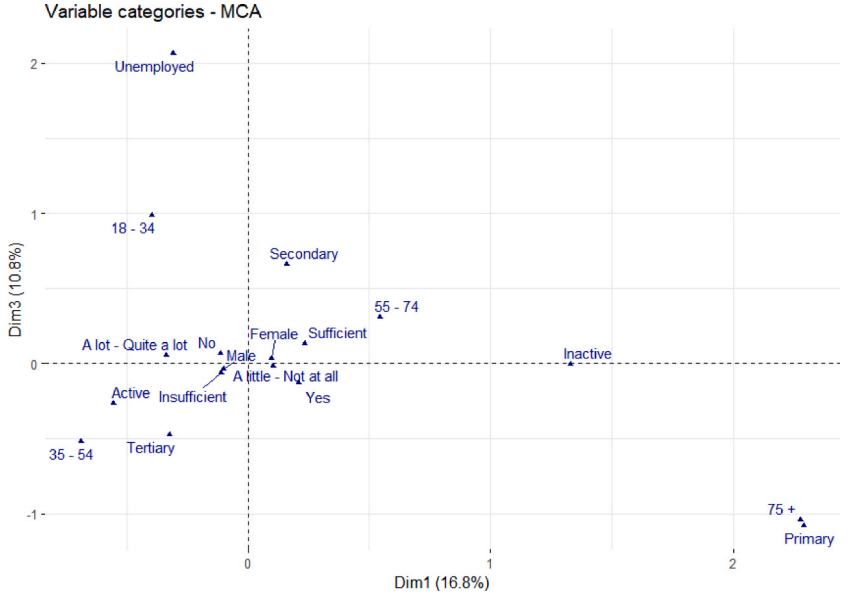

Fig. A1. Two-dimensional correspondence plot using MCA (dimensions 1 and 3).

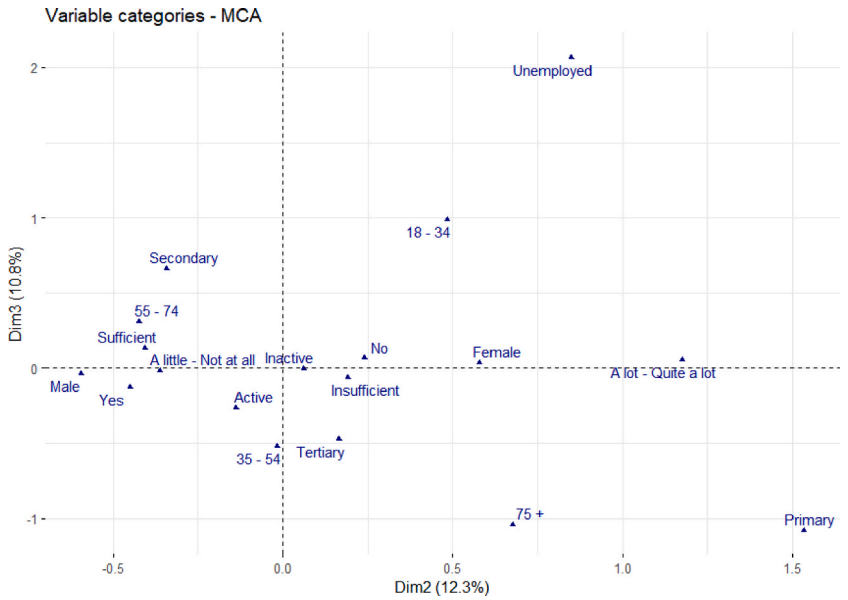

Fig. A2. Two-dimensional correspondence plot using MCA (dimensions 2 and 3).

Data availability

Data will be made available on request.

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