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Examining the Relationships between Religious Affiliation, External and Internal Behavioural Factors, and Personal Carbon Footprint

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Abstract: Different studies have shown that daily consumption is responsible for a large portion of greenhouse gas emissions. Since consumption is closely linked to individuals' preferences, motivations, and beliefs, the personal carbon footprint should be a good indicator of actual consumers' commitments towards climate change mitigation. Previous research has shown the importance of considering individual-level religion as an antecedent of mitigation outcomes, although the evidence is inconclusive in this regard. This study examines the relationship between religious affiliation and personal carbon footprint, following socio-psychological models that consider behaviour to depend on external or situational factors, and internal or intrinsic ones. A questionnaire was carried out on a random sample of the Spanish population (N = 845) to determine the main drivers of carbon footprint for different religious groups. External factors (i.e., socioeconomic) and internal ones related to climate change knowledge, commitment, and intractability, on the one hand, and value orientation, nature-relatedness, and the main motivation to conserve nature on the other hand, were analysed. Intergroup differences in the personal carbon footprint were found, especially based on sex, age group, and type of work among external factors and value orientation, the main motivation for conserving nature and climate change perceived commitment within the internals. Intragroup differences for food carbon footprint were also observed, as follows: the main motivation to conserve nature and the level of commitment implied differences among Catholic believers, whereas value orientation and the level of commitment implied differences among non-believers. Our conclusions suggest, on the one hand, the importance of examining the religion-mitigation link in a socio-psychological framework and, on the other, the need for further study within groups to promote better behavioural responses to climate change.

Keywords: climate change; carbon footprint; religion; religious affiliation; behaviour

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1. Introduction

Although climate change (CC) is one of the greatest problems we face as a society (IPCC 2021), current emission reduction and mitigation policies are far from meeting the goals indicated by the scientific community to avoid dangerous warming levels, particularly those included in the Paris Agreement (Victor et al. 2017). Limiting human-induced global warming implies cutting down greenhouse gas (GHG) emissions, not only at the institutional and organizational levels but also at societal and individual ones (O'Neill et al. 2014; Schultz and Kaiser 2012). Indeed, the literature reports that a large part of the total GHG emissions (between 60 and 70%) is related to personal consumption habits, so modifying emission trends requires a significant change in current lifestyles, particularly in Western societies (Franzen and Mader 2018; Ivanova and Büchs 2020; Richardsen Moberg et al. 2019).

Therefore, a better understanding of factors affecting individual behaviour, which would encourage people to reduce their emissions, is crucial to promote more efficient mitigation policies. Religious beliefs are one such factor that have received increasing attention

in the last few years, and such beliefs have been shown to be related to environmental motivations (Chuvieco and Burgui 2016), sustainable consumption (Minton et al. 2015), and CC perceptions and attitudes (Jenkins et al. 2018). Considering the large global influence of religions, with a high level of affiliation (it is estimated that 84% of the world's population identify themselves with a religious denomination (Pew Research Centre 2017)), their influence in world education (Palmer and Finaly 2002), their importance in the conservation of natural areas (Mallarach et al. 2016), and their impact on personal worldviews and ethical guidance (Sherkat and Ellison 2007), religious beliefs are indeed an important factor in understanding CC commitment, both at the societal (Rolston III 2009; Tatay-Nieto 2020) and individual levels (Cohen and Rozin 2001; Lakhan 2018).

Although religion has been foregrounded as an antecedent of different environmental outcomes (Gifford and Nilsson 2014), the empirical evidence is mixed on whether religion at the individual level promotes or constrains CC mitigation. Considering religious denomination, the evidence seems to suggest that conservative Christians are less concerned about CC, because of an association with political conservatism (Arbuckle 2017; Smith and Leiserowitz 2013), although some researchers point out that this evidence is restricted to the North American context (Morrison et al. 2015). In the case of Catholic believers, reporting positive (vs. negative) attitudes towards CC are associated with religious views of stewardship or human responsibility (vs. dominance) over nature (Agliardo 2013; Eom et al. 2021). In a broad sense, it seems that Catholics express higher levels of concern about CC than those belonging to other Christian churches, but believers, in general, are less concerned than people with no religious affiliation (atheists, agnostics) (Pew Research Centre 2015). However, there is cross-national evidence supporting the contrary (Kvaløy et al. 2012).

Several scholars point out that inconclusive findings may be related to a conceptualization problem, generally focused on the analysis of isolated antecedents, such as political orientation or a dominion's views (Clements et al. 2014; Peifer et al. 2016). A step forward would be to consider religion as influencing environmental outcomes in complex ways and through interactions with other socio-psychological antecedents of behaviour (Michaels et al. 2021). The types of models that consider two main groups of behavioural factors are as follows (Gifford and Nilsson 2014; Clayton and Myers 2015): the external or situational ones, related to the environment and socioeconomic conditions (Corral-Verdugo et al. 2020), and the internal or intrinsic, related to individuals' knowledge, motivations, and beliefs (Schultz and Kaiser 2012; Steg et al. 2015; Steg et al. 2016). Based on these, we argue that religion at the individual level could be a sound basis for the adoption of low-carbon lifestyles by underlying or interacting with these sets of behavioural antecedents (Orellano et al. 2020).

Therefore, we focus our research specifically on understanding the relationships between religious affiliation, external and internal antecedents of behaviour, and personal carbon footprint (CF), as an indicator of consumption-related emissions. Using this observed measure instead of self-reports should provide a more rigorous assessment of the personal impact on CC mitigation, as previous research has shown that self-assessments are not necessarily linked to actual behaviour (Kormos and Gifford 2014; Moser and Kleinhückelkotten 2018; Steg and de Groot 2019).

Regarding external factors affecting the relationships previously mentioned, there are well-established links between socioeconomic indicators and CF; past research has shown the positive influence of income on CF (with higher incomes resulting in higher CF), the non-linearity of age (with lower CF for younger and older citizens), and the impact of the type of work (with lower CF for students and home workers), among others (Chuvieco et al. 2021; Büchs and Schnepf 2013; Bhoyar et al. 2014; Brand and Preston 2010).

Internal factors have been widely recognized as having a long-term effect on consumption habits, particularly those related to curtailing behaviours (Gifford and Chen 2017). We have selected value orientation, motives to conserve nature, and nature-relatedness in our analysis, as they are relevant to environmental behaviour (Pearson 2016; Steg et al. 2015; Whitburn et al. 2019), although their role in consumption-related emissions has not been

previously researched. Value orientation was directly related to CC attitudes and self-report mitigation behaviour (Bouman et al. 2018; Steg 2018), while peoples' motives for conserving nature, its appreciation, and sense of connectedness (i.e., nature-relatedness) are suggested in the literature as significant for understanding environmental views and beliefs that are antecedent of attitudes and behaviour (Pearson 2016; Mace 2014). Additionally, research has shown that CC knowledge, perceived intractability, and the level of commitment are relevant to understanding mitigation outcomes, as they undergird much of consumers' decisions (Pickering et al. 2021; van Valkengoed and Steg 2019; Poortinga et al. 2019; Corner et al. 2014).

To summarize, we aim to better understand the role of religious affiliation in explaining personal CF, and more specifically, to (1) examine intergroup differences, i.e., whether religious affiliation implies differences in personal CF, (2) analyse intragroup differences and whether external and internal factors mediate these differences, and (3) test how these interactions affect personal CF values, particularly for food and transport, the most important sectors of personal emissions (Büchs and Schnepf 2013; Druckman and Jackson 2016).

2. Materials and Methods

2.1. Participants and Procedures

Data were collected using a questionnaire, conducted by a social research company which specialized in online surveys (Netquest Soluciones de investigación S.L). The company follows the ISO 20,252 standard for the selection of panellists; it also complies with the European General Data Protection Regulation (GDPR) and the Organic Law on Data Protection and Guarantee of Digital Rights (LOPDGDD) applied in Spain. The research company requests the consent of its panellists and informs them about the protection and the irreversible anonymization of their data, assuring that the respondent cannot be identified. Additionally, the survey included a brief introduction guaranteeing the anonymity and confidentiality of all participants, its voluntary nature, and that it could be abandoned at any time.

The sample was addressed to 1000 people following a stratified protocol to represent the geographical variety of the Spanish population. The survey included internal checks to filter potentially incorrect answers from the CF-related section, where we asked participants to introduce an estimate of their consumption, setting up a range of reasonable minimum and maximum values for each item. However, some answers were still found to be unreliable, so we first filtered the questionnaire manually, rejecting unrealistic responses. Then, we searched for anomalous cases using an automatic classification system. We grouped the CF values into five categories using the k-means algorithm (Likas et al. 2003) and reject those records assigned to groups with very few assigned cases (<30 people). The process was repeated 4 times until there were no marginal clusters (all groups had at least 50 cases). Following this process 845 cases were retained (84% of the original sample), which were used for further analysis.

The socio-demographic data of the final sample was as follows: 48% of the participants were female. In terms of age, 3% of the participants were between 16–17 years old; 16% were between 18–30 years old; 66% were between 31–65; 15% were 66 years old or above. In terms of religious affiliation, the outputs of our survey showed that 60.0% of the informants described themselves as religious. From this group, the majority were Christian Catholics (46.6%), followed by other Christians (2.9%), Buddhists (1.8%), Hindus (0.4%), Muslims (0.5%), and other confessions (7.8%). Since the number of believers of confessions other than Catholic was very small in the sample, we grouped them into the following groups: Catholic believers (46.6%), other-believers (13.4%), and non-believers (40.0%). Descriptive statistics and correlations are depicted in Tables A2 and A3, Appendix A.

2.2. Measures

Carbon footprint. We asked participants to introduce a quantitative estimation of their consumption for different categories (transport, food, household energy, clothes, and

others), and then we calculate their emissions in $kgCO_2eq$ following the specifications of the Carbon Footprint Observatory's "CO_2 web" (https://www.huellaco2.org/; last access on 16 September 2021). See (Burgui-Burgui and Chuvieco 2020) for a full description of the calculator.

Religious affiliation. We used one single item to assess participants' religious affiliation (Pew Research Centre 2017). The options were Christian Catholic, Other Christian Churches, Buddhist, Hindu, Muslim, and Agnostic or Atheist.

Internal factors: We considered two groups of internal factors, those related to general environmental concern and those particularly associated with CC. Among the former, the following were included in the questionnaire: *(a) Motives to conserve nature.* In line with previous research, we assessed respondents' main motivation for conserving nature by giving them several options to choose from (human responsibility, religious reasons, the intrinsic value of nature, economic motives, health, or well-being). These were adapted from (Chuvieco and Burgui 2016) and (Pearson 2016). *(b) Value orientation.* We asked participants about their value orientation (altruism, vulnerability, resilience, egoism) using a measure adapted from (Steg et al. 2016) and (Steg 2016). *(c) Nature-relatedness*. We measured this antecedent using the short version of the nature-relatedness scale from (Nisbet and Zelenski 2013), which includes a series of statements to assess participants' connection to nature (e.g., "my relationship with nature is an important part of who I am"). Within the group of CC-related factors, we included the following: *(a) Climate Change Knowledge*. We asked participants about their knowledge of CC causes and the implications of human action (e.g., "Climate Change is mainly due to human action"). This measure was extracted from (Chuvieco et al. 2021). *(b) Level of commitment.* We asked participants their perception of personal commitment and if they perceived their emissions to be above or below the national average, as extracted from (Chuvieco et al. 2021). This measure was recoded in three categories: 1. highly committed and below-average emissions (self-perceived as having a low CF); 2. highly committed and above average (self-perceived as having a medium-high CF); 3. otherwise (no clear commitment to CC). *(c) Perceived intractability*. We asked participants about their perception of personal intractability (i.e., the importance of individual action to fight against CC). This was adapted from (Xiang et al. 2019). This variable was recoded as 1. the importance of personal actions in CC mitigation was high or very high, and 2. otherwise.

External factors. As external variables we used sex, age group, level of studies, monthly income, type of work, and political orientation, as these were found to be related to CF in previous studies (R. Gifford and Nilsson 2014; Chuvieco et al. 2021). All measures and details in terms of descriptive statistics are in Tables A1 and A2 of Appendix A.

2.3. Analytical Strategy

Out of the five components of CF, we focused mainly on the transport and food sectors, as they account for 43% and 30% of total CF in our results, respectively, while they have also been identified as the most clearly linked to daily habits and personal decisions (Büchs and Schnepf 2013; Druckman and Jackson 2016).

Relationships between CF and its components were explored using correlation and dispersion plots. Association metrics for categorical variables were based on the Chi-square test and differences between sample groups with the Kruskal–Wallis (KW) non-parametric test, identifying which groups differed from others through post-hoc comparisons.

To determine the relative importance of the explanatory variables on relevant CF components, we chose a data-driven (i.e., automatic) method to run a non-parametric kernel regression (Racine 2019). The classical parametric approach to estimating these relationships requires specifying the functional form for the continuous variables and the nature of any interactions among all quantitative and qualitative regressors. If any of these assumptions are incorrect, the estimated model will be biased. Indeed, we first ran a test to verify the null hypothesis that a parametric model fits the data. We used a consistent model specification test (Hsiao et al. 2007) but the model was not shown to be

significant (p = 0.185). Next, we proceeded with non-parametric methods, as they are less deterministic, to select the appropriate model (Racine 2008). The final model was based on a locally weighted least squares estimator, which is also known as local linear kernel regression (Li and Racine 2004). This model combines a simple regression model with a local weight function called a kernel function denoted as follows:

$$K\left(\mathrm{Z_i}\right) = \frac{\mathrm{K(x - X_i)}}{h} \quad (1)$$

where x and i are vectors of regressors and h is a smoothing parameter called bandwidth.

The direct counterpart of model selection for parametric approaches is bandwidth selection, a key aspect of non-parametric kernel methods. Non-parametric regression computes a bandwidth object for a p-variate kernel regression estimator defined over mixed continuous and discrete (unordered, ordered) data using least-squares cross-validation (Li and Racine 2004). To evaluate the goodness of fit the model returns an r-squared, denoted as follows:

$$R^2 = \frac{\sum_{i=1}^{\mathrm{n}}(\gamma i - \hat{\gamma} i)(\hat{\gamma} i - \gamma i)2}{\sum_{i=1}^{\mathrm{n}}(\gamma i - \hat{\gamma} i)2 \sum_{i=1}^{\mathrm{n}}(\hat{\gamma} i - \gamma i)2} \quad (2)$$

where γi is the outcome and $\hat{\gamma} i$ the fitted value for observation i, and R^2 will always lie in the range [0, 1] where 1 denotes a perfect fit to the sample data and 0 denotes no predictive power. Finally, to find relevant predictors, we first established the null that a predictor was irrelevant (the same as when doing a t-test of significance), and then we calculated the p-values. For those p-values less than 0.05, we rejected the null at the 5% level and concluded that the predictors were relevant.

These analyses were processed in R software, version 4.1.0 with np package (Racine and Hayfield 2020). The function npreg() in this package automates the procedure explained above and allowed us to do a non-parametric regression, and to automatically choose the appropriate bandwidth using least-squares cross-validation (Hayfield and Racine 2008).

3. Results

3.1. Interactions between Religious Affiliation and External and Internal Factors

First, we examined the relationships between religious affiliations and external factors to test whether the potential explanation for differences in CF between religious groups might be related to cross-relationships with other variables. Table A3 of Appendix A provides descriptive statistics for each religious affiliation. Table 1 shows that only level of studies and political orientation among the external factors introduce differences between religious groups. Post-hoc comparisons show that other-believers had a low level of education than their alternative groups, while for political orientation, Catholics were closer to right and non-believers closer to left orientation. Of the internal factors, religious groups were associated with the main motivation to conserve nature, nature-relatedness, CC knowledge, and perceived commitment. The other internal variables did not show significant differences among religious groups.

From the significant differences, we observed that Catholic believers tended to prioritize human responsibility, and health and well-being, over other motivations for preserving nature, while for other-believers and non-believers, the main reason was the intrinsic value of nature, also followed by health and well-being (Table A4, Appendix A). All groups claimed to have a high connection to nature, although other-believers showed higher values than other groups (Table A5, Appendix A). As for CC knowledge, non-believers reported more knowledge about the anthropogenic cause of CC (with low importance of natural factors: Table A6, Appendix A), while Catholics reported the lowest knowledge. Related to the association between religious affiliation and CC perceived commitment (Table A7, Appendix A), in relative terms non-believers showed the highest degree of perceived commitment, with the lowest of both among Catholics, although all religious groups had a majority of respondents identified with the "no particular commitment" category. Finally, CC intractability did not show any significant differences (Table A8, Appendix A).

Table 1. Association between external and internal variables and religious groups.

External and Internal Factors	Statistic	*p*-Value
Sex	3.530	0.169
Age group	10.238	0.235
Level of studies	13.044	**0.001**
Monthly income	7.565	0.560
Type of work	1.258	0.262
Political orientation	91.011	**<0.001**
Main motivation to conserve nature	48.261	**<0.001**
Nature-relatedness	12.640	**0.009**
Value orientation: egoistic	5.072	0.079
Value orientation: vulnerability	2.383	0.304
Value orientation: altruistic	3.155	0.207
Value orientation: resilience	0.013	0.940
CC Knowledge	14.784	**0.001**
CC Perceived commitment	13.348	**0.009**
CC Perceived intractability	0.087	0.957

p-values in bold are significant.

3.2. Differences in Personal Carbon Footprint across Religious Groups Based on External Factors

The mean personal CF of our sample was 5010 kg of COeq, which was lower than the per capita emission rate of Spain for the same year, 2019 (6861.21 $kgCO_2eq$/year: https://www.ine.es/jaxi/Tabla.htm?path=/t26/p084/base_2010/serie/&file=01004.px, last accessed on 24 February 2022). It should be noted that our estimation did not include emissions linked to construction or export goods, nor touristic lodgings. Out of total emissions, 73% were produced by transport (43%) and food (30%), far more than from other CF components, such as household energy consumption (10%), clothing (6%), and others (11%). As such, we focused the analysis on the following three CF components: total, transport, and food.

As observed in Table 2, age group and type of work introduced significant differences in all CF sectors for the overall sample. Young people, students, and domestic workers had significantly lower total and transport CF than their alternative groups, while domestic workers had higher food CF. Focusing on the level of studies and income, we observed that those who had the highest level of education (university degree and higher) and higher income were also those who had the highest total and transport CF. Sex only implied differences for the transport sector, with women having the lowest CF. Finally, political orientation was not significantly associated with CF, neither in the total CF nor in any of its components.

Table 2. Kruskal–Wallis values from testing CF differences between external factors.

External	Total		Food		Transport	
Factors	Statistic	*p*-Value	Statistic	*p*-Value	Statistic	*p*-Value
Sex	2.97	0.085	0.05	0.823	26.56	**<0.001**
Age group	15.96	**0.001**	8.30	**0.040**	29.43	**<0.001**
Level of studies	6.65	**0.036**	1.82	0.402	18.62	**<0.001**
Monthly Income	31.73	**<0.001**	2.72	0.256	53.65	**<0.001**
Type of work	21.57	**0.006**	20.47	**0.009**	42.70	**<0.001**
Political orientation	2.59	0.274	5.28	0.072	0.650	0.722
Religious affiliation	3.936	0.140	12.034	**0.002**	0.781;	0.677

p-values in bold are significant.

Religious affiliation was not found to be significantly related to the total and transport CF components, but it was for the food CF. Within religious groups, Catholics showed significantly higher food CF than non-believers.

Table 3 presents intergroup differences in CF, considering external factors. In this case, most relations are not significant, meaning that all religious groups have similar CF within the different categories of external factors. Only within food CF were differences found for women, adult population (30–65), and administration and home workers. Non-believing women, those belonging to the adult population (30–65 years old), and those working in the administration sector had a lower CF than Catholic believers of those categories. In addition, domestic workers of other believers had lower CF values than Catholics.

Table 3. Differences in personal CF across religious groups for each external factor.

External Factors		Total		Food		Transport	
	Categories	**Statistic**	***p*-Value**	**Statistic**	***p*-Value**	**Statistic**	***p*-Value**
Sex	Male	1.634	0.442	1.324	0.516	6.201	0.050
	Female	3.291	0.193	14.290	**0.001**	0.008	0.996
Age (years)	<18	3.613	0.164	3.439	0.179	0.237	0.888
	18–30	0.621	0.733	0.318	0.853	0.632	0.729
	30–65	0.890	0.641	12.158	**0.002**	0.978	0.613
	>65	0.483	0.786	0.417	0.812	1.155	0.561
Level of studies	Primary	1.354	0.508	1.190	0.551	4.477	0.107
	Secondary	0.599	0.741	6.155	0.051	0.499	0.779
	University	0.808	0.668	5.524	0.063	1.202	0.548
Income (€)	<1500	5.247	0.073	2.414	0.299	6.265	0.051
	1500–3000	0.799	0.671	2.803	0.246	0.313	0.855
	>3000	2.118	0.347	2.597	0.273	0.028	0.986
Political Orientation	Left	0.055	0.973	7.040	0.051	2.640	0.267
	Centre	0.904	0.636	5.831	0.054	3.998	0.135
	Right	0.111	0.946	0.230	0.988	1.385	0.500
Type of work	Student	0.265	0.876	4.361	0.113	2.815	0.245
	Agriculture	4.200	0.122	0.611	0.737	2.800	0.247
	Industry	0.930	0.628	1.812	0.404	0.126	0.939
	Administration	1.144	0.564	10.636	**0.005**	0.256	0.880
	Education	2.087	0.352	1.871	0.392	1.926	0.382
	Catering	1.418	0.492	2.792	0.248	0.730	0.694
	Health, Military	0.943	0.624	1.276	0.528	3.019	0.221
	Entrepreneurs	0.245	0.882	0.534	0.766	0.725	0.696
	Homeworkers	5.503	0.064	16.509	**<0.001**	2.902	0.234

p-values in bold are significant.

Table 4 shows results for CF differences within religious groups, related to external factors. In the case of Catholic believers, the largest differences were found in the transport sector. Women and those older people (>65 years) had the lowest CF value, while adults (30–65 years) had the highest. Level of studies, monthly income, and type of work also implied differences among Catholics, with the lowest level of education and income having the lowest CF values. Regarding the type of work, students and home workers had the lowest transport CF, and workers in the industry the highest. Age group and monthly income also imply differences among this group, being the lowest CF of those with the lowest income; older people (>65 years) had also the lowest CF value among age groups, while adults (30–65 years) had the highest. In the case of other-believers, those with the lowest level of education and income were those with the lowest transport CF. Relative to non-believers, women had lower total and transport CF than men; younger people have the lowest total and transport CF, and adults (30–65) have the highest; those with lower incomes were also those with a lower transport CF. Finally, home workers had the highest food CF, while students had the lowest.

Table 4. Differences in personal CF across external factors for each religious group.

External Factors	Catholics Believers					
	Total		Food		Transport	
	Statistic	*p*-Value	Statistic	*p*-Value	Statistic	*p*-Value
Sex	3.055	0.890	0.070	0.125	26.56	**0.005**
Age group	8884	**0.031**	6.850	0.077	12.99	**0.005**
Level of studies	4.701	0.095	1.073	0.585	7.311	**0.026**
Monthly Income	29.572	**<0.001**	2.995	0.224	27.799	**<0.001**
Type of work	12.761	0.120	13.624	0.092	25.167	**0.001**
Political orientation	1.529	0.466	0.341	0.843	1.669	0.434
	Other-Believers					
Sex	2.25	0.786	0.060	0.412	27.56	0.479
Age group	0.805	0.848	1.141	0.767	6.564	0.087
Level of studies	3.413	0.181	0.225	0.894	7.786	**0.020**
Monthly Income	5.323	0.070	3.617	0.164	12.796	**0.002**
Type of work	14.533	0.069	14.562	0.068	16.862	0.056
Political orientation	1.050	0.592	2.546	0.280	1.397	0.497
	Non-Believers					
Sex	3.56	**0.004**	0.060	0.302	21.89	**<0.001**
Age group	9.732	**0.021**	5.540	0.136	0.046	**0.046**
Level of studies	0.375	0.829	1.568	0.457	4.439	0.109
Monthly Income	2.105	0.349	0.201	0.904	13.152	**0.001**
Type of work	6.608	0.579	21.281	**0.006**	10.598	0.226
Political orientation	0.343	0.842	3.558	0.169	1.384	0.501

p-values in bold are significant.

3.3. Differences in Personal Carbon Footprint across Religious Groups Based on Internal Factors

Table 5 presents the results of CF differences across religious groups for the internal factors. None of them introduced significant differences between religious groups concerning total CF. For food CF, resilience value, CC knowledge, CC perceived commitment and CC intractability introduced significant differences between religious groups, while for transport CF, only the main motivation to conserve nature introduced differences. Among those indicating the role of human responsibility as a strong motivation of nature conservation, Catholics had lower transport CF than non-believers. Finally, those non-believers having higher levels of resilience value orientation, CC knowledge, CC perceived commitment and CC intractability were found to have significantly lower food CF than Catholics, having no significant differences with the other-believers group.

Table 5. Differences in CF across religious groups for each internal factor.

Internal Factors		Total		Food		Transport	
	Categories	Statistic	*p*-Value	Statistic	*p*-Value	Statistic	*p*-Value
The main motivation for conservation	Human responsability	2.078	0.354	1.100	0.577	6.145	**0.046**
	Religious reasons	1.125	0.724	1.125	0.289	0.125	0.724
	Intrinsic value	3.354	0.187	2.658	0.265	0.137	0.504
	Economic motives	2.879	0.237	3.480	0.176	0.757	0.685
	Health or well-being	0.264	0.876	4.678	0.096	1.564	0.457
Value Orientation	Egoism	2.794	0.247	4.919	0.085	1.632	0.442
	Vulnerability	0.194	0.907	1.799	0.407	3.369	0.186
	Altruism	0.876	0.645	5.888	0.053	4.175	0.124
	Resilience	2.716	0.257	10.636	**0.050**	0.235	0.889
Nature relatedness		4.649	0.098	4.292	0.117	0.614	0.36

Table 5. *Cont.*

Internal Factors	Categories	Total		Food		Transport	
		Statistic	*p*-Value	Statistic	*p*-Value	Statistic	*p*-Value
CC Knowledge	GHG main cause	3.385	0.184	11.986	**0.002**	2.362	0.307
	Otherwise	0.384	0.825	1.666	0.435	0.985	0.611
CC Perceived commitment	Highly committed, below-average emissions	0.530	0.767	4.140	0.126	2.738	0.254
	Highly committed, above-average emissions	0.183	0.913	7.755	**0.021**	3.339	0.188
	Otherwise	0.214	0.899	2.994	0.224	0.359	0.836
CC Intractability	Importance of personal actions high or very high	1.671	0.434	10.907	**0.004**	2.241	0.326
	Otherwise	1.067	0.587	2.988	0.224	2.058	0.357

p-values in bold are significant.

Table 6 shows CF differences within religious groups related to internal factors. Only CC perceived commitment was found to introduce significant differences among Catholics in food CF, showing the lowest CF values for people with a high level of commitment. For other-believers, none of the internal factors implied significant differences in any of the CF dimensions, while for non-believers, value orientation was found to be relevant for total and transport CF. In this case, those having higher levels of resilience values had lower transport CF, while those having lower levels of egoistic values had lower total and food CF.

Table 6. Differences in personal CF across internal factors for each religious group.

Internal Variables	Catholics Believers					
	Total		Food		Transport	
	Statistic	*p*-Value	Statistic	*p*-Value	Statistic	*p*-Value
The main motivation for conservation	4.829	0.305	6.864	0.143	1.451	0.835
Value Orientation: egoism	6.177	0.186	1.279	0.865	4.151	0.386
Value Orientation: vulnerability	1.811	0.771	0.986	0.912	2.759	0.599
Value Orientation: altruism	2.873	0.579	2.020	0.732	0.502	0.973
Value Orientation: resilience	3.515	0.476	1.430	0.839	0.992	0.911
Nature relatedness	0.806	0.651	2.059	0.357	2.075	0.354
CC Knowledge	18.755	0.595	19.701	0.759	17.381	0.080
CC Perceived commitment	3.482	0.175	6.003	0.045	3.928	0.140
CC Intractability	18.575	0.868	16.882	0.170	19.603	0.271
	Other-believers					
The main motivation for conservation	2.205	0.698	1.234	0.872	2.275	0.685
Value Orientation: egoism	5.362	0.252	7.332	0.119	0.975	0.914
Value Orientation: vulnerability	3.290	0.511	1.588	0.811	5.650	0.227
Value Orientation: altruism	3.122	0.538	2.175	0.704	4.101	0.393
Value Orientation: resilience	2.039	0.729	1.169	0.805	1.109	0.893
Nature relatedness	2.193	0.334	3.780	0.151	0.017	0.991
CC Knowledge	1.824	0.138	1.902	0.530	1.53	0.975
CC Perceived commitment	1.350	0.509	4.531	0.104	1.327	0.515
CC Intractability	1.698	0.219	1.662	0.308	1.508	0.920
	Non-believers					
The main motivation for conservation	5.409	0.144	2.473	0.480	5.950	0.114
Value Orientation: egoism	15.480	**0.040**	9.815	**0.044**	3.640	0.457
Value Orientation: vulnerability	3.226	0.521	2.931	0.569	2.311	0.679
Value Orientation: altruism	7.694	0.103	6.835	0.145	7.012	0.135
Value Orientation: resilience	4.541	0.338	2.890	0.576	13.249	**0.010**
Nature relatedness	0.082	0.960	3.224	0.220	0.123	0.940
CC Knowledge	13.807	0.936	15.462	0.050	12.493	0.158
CC Perceived commitment	1.712	0.425	3.225	0.199	0.569	0.752
CC Intractability	12.997	0.611	12.983	0.600	14.061	0.476

p-values in bold are significant.

3.4. Regression Models

In this section, we focused on food CF to deepen the effect of religious beliefs, since this sector showed most of the significant differences between religious groups. In addition, it was identified by different studies as one of the most clearly linked to daily habits and personal decisions (Büchs and Schnepf 2013; Druckman and Jackson 2016).

Before running the regression model, we checked for collinearity between factors. Except for monthly income and the level of studies (rs= 0.4, $p = 0.001$), collinearity was low between them (Table A2, Appendix A). Therefore, we included all factors in the regression model, except for monthly income, as this variable had unfilled responses and was highly correlated with the level of studies. Two regression models were run, for Catholic and non-believers. Other-believers were not considered in this analysis, as no significant relations were found in food CF in any of the external or internal factors.

Table 7 presents the results of regression models. The models explain food CF for non-believers (R^2 Food CF =0.38), with the age group of the external factors and value orientation for the internal factors resulting significant. For Catholic believers (R^2 Food CF = 0.35), age group, main motivation to conserve nature, and the level of CC perceived commitment were found to be significantly associated with food CF.

Table 7. Non-parametric regression model with internal and external factors for Food CF.

	Food Carbon Footprint	
	Catholics Believers	**Non-Believers**
Sex	0.133	0.870
Age group	0.007 **	0.000 ***
Level of studies	0.687	0.051
Type of work	0.083	0.067
Political orientation	0.073	0.406
Main motivation to conserve N	0.030 *	0.058
Value orientation: egoism	0.198	0.023 *
Value orientation: vulnerability	0.461	0.233
Value orientation: altruism	0.338	0.298
Value orientation: resilience	0.172	0.118
Nature relatedness	0.719	0.118
CC Knowledge	0.687	0.080
CC Perceived Commitment	0.018 *	0.002 *
N	394	338
R-squared	0.35	0.38
Residual standard error:	0.508	0.520

p-values are significant at * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

4. Discussion

4.1. Main Findings

This study has shown the value in considering religious affiliation in order to better understand how consumption habits impact CC mitigation. We have shown the variability in GHG emissions for different religious groups, namely Catholic believers, other-believers, and non-believers. Even though past studies analysed the link between religious affiliation, consumption, and CC actions (Leonard and Pepper 2015), they were based on self-perception measures rather than actual behaviour, and it is well known that self-perceived measures are not necessarily linked to actual commitment (Gifford and Chen 2017; Kormos and Gifford 2014). In addition, previous research mainly focused on the analysis of isolated antecedents related to religion at the individual level and mitigation outcomes, but given the influence of several factors affecting CC mitigation behaviour, we examined this link within a social-psychological model that considers behaviour to depend on external and internal determinants (Clayton and Myers 2015; Gifford and Nilsson 2014). Thus, preliminary findings are not intended to resolve the inconsistencies of previous research, but to provide insights from this perspective.

Consistent with previous findings (Chuvieco et al. 2021), our results showed that several external factors were significantly associated with CF values, considering all religious affiliations together. In addition, we observed interesting inter- and intra-group differences in personal CF based on external and internal factors affecting consumers' behaviour. Clearly, the CF for the food sector is the most closely related to the interactions between religious affiliation and those factors. Deepening these intergroup comparisons, non-believers were found to have a lower CF than Catholics. Additionally, these groups differ on external factors, as non-believing women, those belonging to the adult population (30–65), those working in administration, and domestic employees had a lower CF than Catholics of the same groups.

It is important to know what internally motivates individuals to support and effectively mitigate CC. Regarding the internal factors, our findings showed that the motivation to conserve nature is an important driver of CF. Human responsibility was more frequently selected among Catholic believers, while the intrinsic value of nature was more valued by non-believers, coincident with previous findings (Chuvieco and Burgui 2016). Intergroup comparisons for internal factors showed that the lowest transport CF was estimated for those Catholics who selected human responsibility as the main motivation to conserve nature, as compared to non-believers. On the other side, those non-believers who had higher levels of resilience value orientation, CC knowledge, CC perceived commitment, and CC intractability were found to have a significantly lower CF than Catholics of the same cohorts.

In addition, intragroup differences revealed the importance of CC perceived commitment among Catholics, showing the lowest food CF values for those with high level of commitment. For non-believers, value orientation was found to be significantly associated with CF, showing that having higher levels of resilience values and lower levels of egoistic values led to lower CF.

Finally, the regression model showed that the main factors controlling food CF for Catholics were age group, and the main motivations to conserve nature and CC perceived commitment. The age group was also relevant for food CF of non-believers, joined by value orientation.

4.2. Implications

Although these findings should be considered as a first approximation to the implications of religious affiliation in personal consumption linked to the CF indicator, there are some potential implications that may derive from our findings. One is to deepen intragroup study, leaving aside the idea of homogeneous groups within each religious affiliation. Thus, to promote effective ways of CC engagement and action, efforts should focus on addressing the potentials and misperceptions of each group. For example, our findings support previous evidence that non-believers have higher agreements about the anthropogenic cause of CC (Morrison et al. 2015; Zaleha and Szasz 2015; Uzarevic and Coleman 2021), in contrast to believers (Barker and Bearce 2012; Ecklund et al. 2016; Zaleha and Szasz 2015), and this is useful for designing mitigation policies, but at the same time, they express difficulties in handling CC anxiety (Hope and Jones 2014), which should also be considered. The same occurs in the case of believers. Even though they have the least CC knowledge and higher CF values, our findings suggest that these outcomes vary depending on the interaction with other factors, such as the main motivation for nature conservation and the level of CC commitment. This is coincident with the literature that considers religions' influence as multifaceted and dependent on other determinants such as political ideology, fundamentalism, the level of education, and the geographical context (Arbuckle 2017; Kilburn 2014; Lewis et al. 2018; Morrison et al. 2015). However, in linking our results with previous studies, we should consider that they have mostly been conducted in the USA, and mainly focused on differences among Christian denominations. For instance, the relevance of literal versus non-literal interpretation of the Bible was found significantly related to environmental concern (McCammack 2007; Guth et al. 1995). However, in Spain

this distinction is not relevant, as evangelical groups linked to a literal interpretation of the Bible have much less social influence than in the USA.

A second implication of our study relates to the attitude of believers towards CC. A more detailed study should focus on factors affecting some believers' perception of CC that leads them to have opposing opinions on CC (Dickinson et al. 2016), in spite of the general calls of religious authorities to support CC action. A theological framework adapted to different religious affiliations still needs to be developed in order to find solid grounds for general acceptance of religious principles that would directly link to environmental commitment, similarly to the generalized agreement on other issues, such as concerns for the poor (Pew Research Centre 2015). It is suggested in the literature that religion at the individual level could both diminish concerns through stronger views of dominance and indifference towards nature, and promote it through values of sacredness, spirituality, and stewardship (Preston and Baimel 2021). Religious denominations could provide resources from their traditions to approach issues such as CC, consumption habits, and lifestyles, because of their ability to construct frameworks that can guide those who follow them (Tucker 2003). In this sense, it is important to emphasize the role of prominent religious leaders in promoting lifestyle changes and encouraging a more rigorous commitment to CC actions. Among many examples of these, we can emphasize the interfaith declarations addressed to the different UN Climate Summits (https://interfaithclimate.org/the-statement; last accessed on 16 February 2022), the common declaration of Pope John Paul II and Patriarch Bartholomew on environmental responsibility (Common Declaration on Environmental Ethics. Common Declaration of John Paul II and the Ecumenical Patriarch Bartholomew I 2002) or the encyclical letter *Laudato Si* of Pope Francis (2015). The impact of these initiatives has been wide, but still requires further implementation at the local and individual level (Tsimpo and Wodon 2016; Hanchin and Hearlson 2020; Savino 2019).

4.3. Limitations and Future Research Lines

Although the richness of this study is based on numerical estimations of personal CF based on detailed emission factors, which goes beyond self-perceptions of estimations, certain limitations should be considered. Quantitative estimations of CF require accurate inputs (energy bills, food amounts, transport distances), which are difficult to acquire. Even though all respondents were warned about this before starting the survey, we had to remove questionnaires for including very unlikely CF values, using visual and automatic classification methods. The final values included in our analysis seemed reasonable, but it is not possible to test their actual accuracy.

Limitations also include the generalizability of the results to another cultural or geographical contexts, considering that individuals with the same religious affiliation may behave differently based on other cultural factors. More research outside of North America and European countries is needed to expand our understanding about the relationship between religious beliefs and different measures of consumption, such as the personal FC indicator, to address the north-western bias in existing studies.

Finally, this study only includes the measure of religious affiliation, which leaves aside the possibility of analysing and interpreting, for example, differences based on the degree of individual religiosity, or the frequency of participation in religious services, or considering intrinsic or extrinsic measures of religiosity. There are a wide variety of religious commitments and practices, even within the same religious tradition and affiliation. Future research should focus on more precise measurements of religiosity, which should provide further nuances in the links established in our study. In this regard, our analysis may serve as a starting point for better understanding the role of religious beliefs in CC mitigation.

5. Conclusions

Climate change mitigation at the individual level requires understanding and promoting behavioural change by analysing its underlying factors. Previous studies on the relationship between religion and CC mitigation outcomes present inconclusive findings.

Therefore, we examine an explanation that considers individual-level religion as interacting in complex ways with other socio-psychological antecedents of behaviour. Examining these relationships within this framework allows more robust conclusions to be drawn than the study of isolated factors.

Thus, this study shows that religious affiliation is associated with consumption-related emissions, measuring by the personal carbon footprint indicator, and relevant external and internal antecedents of behaviour. Intergroup differences in the personal carbon footprint were found, especially based on sex, age group, and type of work among external factors, and value orientation, the main motivation for conserving nature, and CC perceived commitment within the internals. Intragroup differences for food carbon footprint were also observed, as follows: the main motivation to conserve nature and the level of CC commitment implied differences among Catholic believers, whereas value orientation and also the level of CC commitment implied differences among non-believers. These preliminary conclusions are not intended to resolve inconclusive findings, but to provide insights for considering the relationship between religion and CC mitigation outcomes in complex ways. From this perspective, we aim to go beyond the debate that focuses only on differences between religious groups, toward an understanding of these complex interactions, so that addressing the misperceptions and potentials of each group will foster better behavioural responses to climate change.

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Appendix A

Table A1. List of variables included in the study.

	Type	Categories	Description
Target Variables			
Carbon footprint	Quantitative	Interval scale	Total, transport, food, clothes, household energy ($kgCO_2eq$)
Religious affiliation	Nominal	3	Catholic believers, other-believers, and non-believers.
Internal Variables			
The main motivation for conservation	Nominal	5	Human responsibility, religious reasons, the intrinsic value of nature, economic motives, health or well-being.
Value Orientation	Ordinal	4	Egoism, vulnerability, altruism, resilience, Likert scale from 1 (strongly disagree) to 5 (strongly agree)
Nature relatedness	Ordinal	6	Likert scale from 1 (strongly disagree) to 5 (strongly agree)
CC knowledge	Binary	2	1 = Identify GHG as the main cause and consider natural factors as having low or very low importance; 2 = otherwise
CC Perceived commitment	Nominal	3	1 = highly committed and below-average emissions; 2 = highly committed and above average; 3 = otherwise
CC Perceived Intractability	Binary	2	1 = importance of personal actions high or very high; 2 = otherwise
External Variables			
Sex	Binary	2	Male 1, female 2
Age group	Ordinal	4	16–17, 18–30, 31–65, >65
Level of studies	Ordinal	3	No studies or primary, secondary school, university studies
Monthly Income	Ordinal	3	<1500 €, 1500 a 3000 € and >3000 €
Type of work	Nominal	9	Student, agriculture, industry, office work, education, catering, other services, management, housework
Political orientation	Ordinal	3	From the original 10 Likert scale, we grouped in 3 classes: left (<4), Centre (4–7) and right mind (>8)

Table A2. Spearman correlation coefficients. *P*-values lower than 0.001 are marked as ** and lower than 0.01 as *.

	Variables	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	Transport CF	1															
2	Food CF	0.02	1														
3	Total CF	0.73 **	0.45 **	1													
4	Sex	0.16 *	0.02	−0.1	1												
5	Age group	−0.01	0.08 *	−0.03	−0.31 *	1											
6	Level of studies	0.15 *	−0.04	0.08 *	0.01	−0.08 *	1										
7	Monthly income	0.3 **	0.02	0.2	0.16	0.09	0.40 **	1									
8	Political orientation	0.03	0.04	0.05	−0.03 *	0.04	−0.02	0.00	1								
9	CC knowledge	−0.08	0.09 *	0.00	0.06	−0.09 *	−0.15 *	0.18	0.17 *	1							
10	Commitment	0.06	0.02	0.07 *	0.06	−0.07 *	−0.05	−0.01	0.15 *	0.21 *	1						
11	Intractability	0.02	−0.03	0.01	−0.09 *	0.08 *	−0.07	−0.02	0.07 *	0.10 *	0.23 *	1					
12	Nature relatedness	−0.02	0.02	−0.03	−0.02	0.01 *	0.02	−0.01	0.13 *	0.12 *	0.34 **	0.22 **	1				
13	Value orientation: egoism	0.04	0.04	0.04	0.04	0.11 **	−0.02	−0.06	0.11 **	0.11 *	0.04 **	0.01	0.05	1			
14	Value orientation: vulnerability	0.04	0.04	0.04	−0.04	0.13 **	−0.01	0.04	−0.01 *	−0.02 *	0.16 **	−0.08 *	0.18 **	−0.17 *	1		
15	Value orientation: altruism	0.01	0.02	0.02	−0.03	0.01 *	0.09 *	0.02	0.12 **	0.12 **	0.25 **	0.14 **	0.30 **	−0.20 *	0.35 **	1	
16	Value orientation: resilience	0.01	−0.01	0.01	−0.00	0.01	0.01	0.03	−0.01	−0.07 *	0.11*	0.1	0.19 **	0.01 *	0.28 *	0.35 **	1

Table A3. Descriptive statistics for the overall sample and each religious group.

	Overall Sample		Catholics Believers		Other-Believers		Non-Believers	
Variables	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**
Transport CF	2163.66	1512.83	2120.14	1506.22	2079.78	1677.80	2242.44	1462.79
Food CF	1509.17	1001.23	1637.51	1064.99	1407.07	914.25	1393.70	934.88
Total CF	5009.93	2167.63	5084.23	2205.09	4931.80	2346.53	4949.44	2062.75
Sex	1.48	0.50	1.49	0.50	1.56	0.50	1.46	0.50
Age group	2.93	0.64	3.08	0.59	2.65	0.74	2.84	0.61
Level of studies	2.48	0.64	2.45	0.61	2.34	0.56	2.55	0.53
Monthly income	2.01	0.75	2.00	0.77	1.86	0.70	2.07	0.74
Political orientation	1.75	0.66	1.96	0.65	1.76	0.60	1.51	0.60
CC knowledge	1.48	0.50	1.53	0.50	1.57	0.50	1.40	0.49
CC Commitment	2.36	0.77	2.45	0.72	2.28	0.77	2.28	0.81
CC Intractability	1.38	0.49	1.39	0.49	1.37	0.49	1.38	0.49
Nature relatedness	3.51	0.77	3.45	0.79	3.73	0.77	3.52	0.74
Value orientation: egoism	2.73	1.12	2.69	1.10	2.96	1.16	2.70	1.12
Value orientation: vulnerability	3.93	0.95	3.97	0.96	3.84	0.99	3.91	0.94
Value orientation: altruism	3.96	0.86	3.91	0.86	4.00	0.92	4.01	0.84
Value orientation: resilience	4.12	0.88	4.12	0.91	4.14	0.90	4.15	0.84

Table A4. Cross-table religious groups and main motivation to conserve nature.

Reasons	Human Responsibility N, Col%, Row%	Spiritual/Religious N, Col%, Row%	Intrinsic Value N, Col%, Row%	Economic N, Col%, Row%	Health and Well-being N, Col%, Row%	Total
Catholic Believers	132, 57.64, 33.50	3, 42.86, 0.76	107, 34.74, 27.16	21, 65.62, 5.33	131, 48.70, 33.25	394, 46.63, 100
Other-Believers	27, 11.79, 23.89	4, 57.14, 3.54	44, 14.29, 38.94	3, 9.38, 2.65	35, 13.01, 30.97	113, 13.37, 100
Non-Believers	70, 30.57, 20.71	0, 0.00, 0.00	157, 51.97, 46.45	8, 25.00, 2.37	103, 38.29, 30.47	338, 40.00, 100
Total	229, 100, 27.10	7, 100, 0.83	308, 100, 36.45	32, 100, 3.79	269, 100, 31.83	845, 100, 100

Table A5. Cross-table religious groups and nature relatedness.

Nature Relatedness	Low N, Col%, Row%	Medium N, Col%, Row%	High N, Col%, Row%	Total
Catholic Believers	38, 46.91, 9.64	131, 55.74, 33.25	225, 42.53, 57.11	394, 46.63, 100
Other-Believers	9, 11.11, 7.96	23, 9.79, 20.35	81, 15.31, 71.68	113, 13.37, 100
Non-Believers	34, 42.98, 10.06	81, 34.47, 23.96	223, 42.16, 65.98	338, 40.0, 100
Total	81, 100, 9.57	235, 100, 27.81	529, 100, 62.60	845, 100, 100

Table A6. Cross-table religious groups and CC knowledge.

Climate Change Knowledge	GHG Main Cause and Natural Factors Low Importance N, Col%, Row%	Otherwise N, Col%, Row%	Total
Catholic Believers	187, 42.67,47.5	207, 50.86, 52.54	394, 46.63,100
Other-Believers	49, 11.19, 43.36	64, 15.72, 56.64	113, 13.37, 100
Non-Believers	202, 46.12, 59.76	136, 33.42, 40.24	338, 40.00,100
Total	438, 100, 51.83	407, 100, 48.17	845, 100, 100

Table A7. Cross-table religious groups and perceived commitment.

Perceived Commitment	Highly Committed, Below-Average Emissions N, Col%, Row%	Highly Committed, Above-Average N, Col%, Row%	Otherwise (No Particular Commitment) N, Col%, Row%	Total
Catholic Believers	53, 34.87, 13.45	109, 46.58, 27.66	232, 50.54, 58.88	394, 46.63, 100
Other-Believers	22, 14.47, 19.47	37, 15.81, 32.74	54, 11.76, 47.79	113, 13.37, 100
Non-Believers	77, 50.66, 22.78	88, 37.61, 26.04	173, 37.69, 51.18	338, 40.00, 100
Total	152, 100, 17.99	234, 100, 27.69	459, 100, 54.32	845, 100, 100

Table A8. Cross-table religious groups and perceived intractability.

Perceived Intractability	High or Very High N, Col%, Row%	Low or Very Low N, Col%, Row%	Total
Catholic Believers	242, 46.27, 61.42	152, 47.20, 38.58	394, 46.63, 100
Other-Believers	71, 13.58, 62.83	42, 13.04, 37.17	113, 13.37, 100
Non-Believers	210, 40.15, 62.13	128, 39.75, 15.15	338, 40.00, 100
Total	523, 100, 62.89	322, 100, 38.1 1	845, 100, 100

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