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What predicts climate concern and pro-environmental behaviour? Case study on an Eastern Hungarian settlement

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Abstract. The study examined climate concern (CC) and pro-environmental behaviour (PEB) regarding climate change. In our research, we chose the second largest city in Hungary, Debrecen. We conducted a questionnaire survey among residents in 2020 (N = 200). The closeness, strength and intensity of the relationship between the predictors, Total Climate Concern Index (TCCI) and PEB Index (PEBI), were examined by correlational analyses. Regression analysis investigated selected variables' relative impacts on and relationships to TCCI and PEBI. We revealed that the TCCI of inhabitants is very high, but PEBI is much lower. In correlational analyses, TCCI and PEBI were each separately found to correlate positively and significantly with AI (Attitude Index, which comprises risk perception and confident willingness to change lifestyle). Still, there was no significant relationship between TCCI and PEBI. In multiple linear regression analyses, higher AI was a significant predictor variable of TCCI, but PEBI was not a significant variable.

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Contents:

1. Introduction

When analysing the challenges and adaptation options that climate change presents, the question of the relationship between climate concerns (CC) and pro-environmental behaviour (PEB) is also often raised (Whitmarsh et al., 2022). In our work, the term "climate concerns" is used to describe how worried individuals are about the problem in their everyday lives (Poortinga et al., 2004; Whitmarsh, 2008; Brulle et al. 2012; van der Linden, 2017; Bodor & Grünhut, 2021; Kiss et al., 2022a).

The umbrella term "pro-environmental behaviour (PEB)" refers to actions, activities and behaviours through which individuals contribute to environmental and/or climate protection by consciously striving to minimise negative impacts. These can be both mitigation and adaptation activities, such as separate waste collection or the use or purchase of energy-saving devices or renewable energy (Steg & Vlek, 2009; Kiss et al., 2022b; Whitmarsh et al., 2022; Lou & Li, 2023; Rabaa et al., 2024), as well as support for environmental policy (Lou & Li, 2023). The terms "pro-environmental action" and "pro-climate action" are often used in the literature, and the terms "climate[-conscious] actions/behaviour" are also often used (Wicker & Becken, 2013; Dienes, 2015; Lou & Li, 2023) with similar meanings.

Continuous monitoring of public CC is extremely timely. In this regard, it is worth mentioning the "finite pool of worry" hypothesis (van der Linden, 2017) according to which, ultimately, people can only worry about a certain number of things at a time. In some periods, growing concern about one problem (e.g., war, terrorism) reduces concern about another problem (e.g., climate change, water scarcity, ecological problems) (van der Linden, 2017; Gregersen et al., 2022). In the period 2020–2023, the world faced a number of difficulties: the COVID-19 pandemic and the Russian invasion of Ukraine, followed by the resulting economic and energy crisis, and the Israeli–Palestinian armed conflict, which, according to the hypothesis reduces concerns about climate change (van der Linden, 2017, Duijndam & Beukering, 2021; Gregersen et al., 2022). According to Bouman et al. (2020), the more concerned someone is about climate change, the more likely they are to take action and support related climate-protection measures, i.e. there is a strong link between the two factors.

The literature on CC and PEB focuses primarily on societies in Western countries (Bouman et al., 2020; Duijndam & Beukering, 2021; Whitmarsh et al., 2022; McCormick et al., 2023); however, in the last few years, some publications have studied the most populous and largest CO_2-emitting countries in Asia, such as China and India (Chan et al., 2023; Tam et al., 2023) or Malaysia and Indonesia (Mostafa, 2017) and countries of Islamic religion (Morocco, Jordan, Turkey, Pakistan) (Mostafa, 2017; Ergun et al., 2021). There is not yet enough literature on the Central and Eastern European region regarding the topic (Kiss et al., 2022b). Furthermore, the countries located here are characterised by a delay in spreading environmentally and climate-conscious behaviour, which may have a negative impact on CC and thus on PEB (Chaisty & Whitefield, 2015). Therefore, our research can be considered to fill a gap. In addition, surveys are most often conducted at national level, and the characteristics of CC and environmentally conscious behaviour at municipal level are hardly studied. By comparing local data, both differences and similarities at the subnational level of a country can be examined (Baranyai & Varjú, 2017).

Overall, little is known about the relationships between CC and PEB and their predictors. Therefore, the main goal of the current study is to explore the relationship and correlations between CC and PEB based on a representative urban sample, as well as the individual contribution of selected variables to the factors mentioned above.

Considering the above-mentioned factors, in the first part of our work, the factors that determine the level of CC and the development of PEB are summarised based on the relevant literature. Then, our results are presented through a case study based on our statistical data analysis. The main research question was: is there any link between the degree of CC and the degree of PEB? Another research question was: are there factors that determine the degree of CC and that contribute to the development of PEB?

Before preforming the statistical analyses, the following hypotheses were formulated:

H1: There is a significant relationship between CC and PEB.

H2: Both CC and PEB have significant relationships with attitudes related to climate change.

H3: Sense of responsibility for climate change is in relationship with PEB, whereas feeling threatened is related to CC.

H4: Demographic factors (gender, age, highest qualification) among predictor variables in regression models have significant impacts on both CC and PEB.

2. Theoretical background

2.1. Direct relationship between CC and PEB

Data collected in different years suggest that the level of CC can vary widely and change relatively quickly (Brulle et al., 2012; Eurobarometer, 2021, 2023). A good example of this is the Eurobarometer report of 2021, according to which, 78% of respondents in the EU considered climate change to be a "very serious" problem, while in Hungary their share was 81%. The EU share decreased to 77% by 2023, while in Hungary it increased to 87%. According to the data of the 2021 report, 49% of respondents in the EU and 37% in Hungary considered climate change to be one of the most serious problems in the world. In the EU, only poverty, hunger and lack of drinking water (54%) were ahead of climate change; by contrast, in Hungary, climate change was considered less important than the spread of infectious diseases (61%), poverty, hunger and lack of drinking water (51%), the economic situation (45%) and nature degradation (40%). According to the latest report in 2023, the proportion of those who consider climate change to be the world's most serious problem has decreased slightly (EU: 46%, Hungary: 33%). In the EU, two problems (poverty, hunger and lack of drinking water; and armed conflicts) were ahead of climate change (58% and 52%, respectively). In Hungary, climate change ranked only fifth (after: poverty, hunger and lack of drinking water – 52%, armed conflict – 44%, economic situation – 40% and nature degradation – 41%).

The findings can be associated with data from Lo and Chow (2015), who found that citizens in richer countries tend to see climate change as the most important problem globally, but are less likely to see it as a threat to their personal life. They also found that climate change is less likely to be considered very dangerous in better-prepared countries.

It is also worth comparing data on PEB with the results of previous years. According to the Eurobarometer survey in 2021, 64% of respondents in the EU and 67% in Hungary had taken action against climate change in the previous six months. By 2023, these rates had reduced to 63% and 61%, respectively. In both surveys, reducing waste and collecting waste separately, reducing the purchase of disposables, and buying energy-saving devices were the activities most people self-reported to have taken to combat climate change. According to Rabaa et al. (2024), when people take energy efficiency actions, they may feel that they have taken a positive step towards climate protection and will therefore later adopt less pro-climate behaviour. In their work, Gifford and Nilsson (2014) point out that many actions are taken by individuals not for environmental reasons or concerns, but rather for economic reasons (e.g., saving money) and these reasons are thus often difficult to separate.

There is a wealth of literature on CC and PEB separately, yet little is known about the deeper connections between the two (van der Linden, 2017). Some authors have found a positive relationship between the two factors, i.e. the more concerned people are, the more likely they are to take pro-environmental actions (Dienes, 2015; Bouman et al., 2020). Others have shown the opposite (Tam & Chan, 2017), whereas some studies suggest no clear link between them (Whitmarsh, 2009; Yu et al., 2013).

2.2. Relationships of CC and PEB to other factors

The degree of CC and the development of PEB can also be associated to many other factors. Examples include feelings of threat and responsibility, level of knowledge, lifestyle and socio-demographic factors.

Many publications show that individuals who describe climate change as a threat and express concern about it are more likely to feel personally responsible and that they are therefore more likely to take actions and are more willing to change their lifestyle or pay higher prices for products to mitigate climate change (Akter & Bennett, 2011; Akter et al., 2012; Wicker & Becken, 2013; Dienes, 2015) and more likely to support mitigation climate policy (Ding et al., 2011; Ballew et al., 2019).

In-depth, extensive knowledge about climate change, as well as a vision of how to tackle it, are associated with increased concerns, which may induce PEB, but lack of concern does not automatically imply lack of knowledge (Steg & Vlek, 2009; Shi et al., 2016; Poortinga et al., 2019; Hoogendoorn et al., 2020). Based on the data of the European Social Survey (ESS) from 2016–2017, it can be concluded that the existence of climate change, the responsibility of anthropogenic activities, and the possible consequences are accepted by the majority of respondents in the European countries studied (Poortinga et al., 2018; Gregersen et al., 2020). Low levels of

CC can also be the result of incomplete or wrong knowledge, misunderstandings or lack of information (Tjernström & Tietenberg, 2008; Brulle et al., 2012). Hidalgo-Crespo et al. (2022) found that thorough environmental knowledge is needed to develop PEB and attitudes in society.

Socio-demographic factors do not always predict the levels of CC and PEB. Scepticism and concern about climate change in Europe show urban and rural differences, where people living in rural areas have more scepticism and less concern than people living in big cities (Weckroth & Ala-Mantila, 2022). Considering the importance of the place of residence, Ergun et al. (2021) have shown the opposite in Pakistan: rural residents have higher levels of concern than urban residents.

Shi et al. (2016) found that demographic factors (gender, age, educational level) do not predict the level of CC but influence its grade. Gregersen et al. (2021) found a significant relationship between CC and demographic indicators: women, younger people, those with higher income and those with higher levels of education are more concerned. The findings of Gregersen et al. (2021) are supported by numerous studies showing that higher levels of CC are exhibited by women (Whitmarsh, 2011; Shi et al., 2016; Poortinga et al., 2019; Ballew et al., 2020; Ergun et al., 2021), younger age groups (Whitmarsh, 2011; Shi et al., 2016; Lewis et al., 2019; Poortinga et al., 2019) and those with a higher level of education (Whitmarsh, 2011; Hornsey et al., 2016; Shi et al., 2016).

3. Research materials and methods

The selected settlement, Debrecen (Fig. 1), has the status of county seat, it is the second most populous city of Hungary (Population: 196,858) (HCSO, 2011), and it is a dynamically developing regional, economic, educational and tourism centre (Vasvári et al., 2013).

The questionnaire survey was conducted between July and September 2020 (N=200). The sampling frame was provided by the data of the census in 2011 of the Hungarian Central Statistical Office (HCSO) by type of locality and data on localities of Hajdú-Bihar County (HCSO, 2011). The respondents were selected by quota sampling, representative of gender and age. During the sample selection, only the population over the age of 18 was taken into account from the 15–19 years age group reported by the HCSO. In addition, we assessed the respondents' highest educational level (non-representative). Data collection was carried out by personal interviewing, using Leslie Kish's systematic sampling, visiting homes (Kiss et al., 2022a).

Communication and word choice play a major role in the development of CC and PEB. Several publications warn that the term "global warming" may evoke higher concerns among individuals than the term "climate change" (Schuldt et al., 2011), although some studies have found no vocabulary difference due to wording in relation to concerns (Villar & Krosnick, 2011). Due to the different results, we pay special attention to the examination of wording in our study. In all of the questions we have compiled, the term "climate change" was used instead of "global warming". The first question of the questionnaire assessed the general concern by listing 12 problems to respondents. The first half of the questions focused on environmental problems (global warming; air pollution; pollution of rivers; waste management; climate change; polluting lifestyles) and the second half on social problems (spread of infectious diseases; migration; poverty, health situation, education situation, unemployment). In order to examine the impact of different concepts on the degree of concern, we have included "global warming" and "climate change" separately among the problems given (Kiss et al., 2022a).

Processing and statistical analysis of the data were carried out using the software SPSS 26. The closeness, strength and intensity of the relationships between CC, PEB and selected predictors were examined by correlation analysis. Subsequently, the impact and relationship of selected variables on CC and PEB was

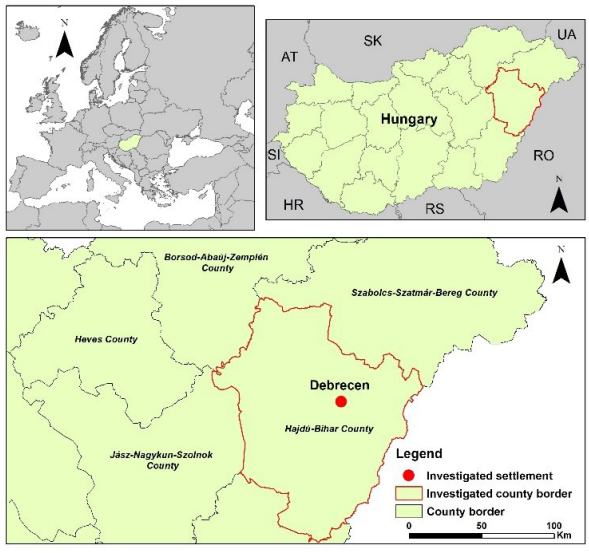

Fig. 1. Location of the study area
Source: authors' work

explored using a multiple linear regression analysis – a methodology taken from the relevant literature (Sajtos & Mitev, 2007; Ballew et al., 2020; Sonnberger et al., 2021; Whitmarsh et al., 2022).

4. Research results

4.1. Descriptive information of variables

Table 1 shows the variables used in statistical analyses and descriptive information. The Total Climate Concern Index (TCCI) was established using the sum of the answers to three questions in order to measure total CC (Cronbach $\alpha = 0.841$). The answers to the first and second questions were measured using a five-step Likert scale (1 – not at all concerned; 5 – totally concerned) and a four-step (1 – not at all serious; 4 – very serious) Likert scale (even forced answer scale) for the third question. The PEB Index (PEBI) was measured by summing responses to the thirteen climate-friendly actions listed (3 – always does, 2 – occasionally does, 1 – would do but cannot, 0 – does not) (Cronbach $\alpha = 0.659$). Subsequently, we established the Attitude Index (AI), measuring the sum of responses to six statements (Cronbach $\alpha = 0.671$) on a five-step Likert scale (1 – not at all concerned; 5 – totally concerned).

4.2. Results of correlation analysis

Prior to the correlation analysis, the impact of word choice in the first question which was related to the level of general concern was studied in our sample. It was found that word choice did not influence the level of general concern (global warming average = 4.24; climate change average = 4.21).

Subsequently, the correlation analysis showed that several variables in our sample were related to CC and PEB (Appendix). The AI ($r = 0.465$, $p < 0.01$) and risk perception ($r = 0.467$, $p < 0.01$) showed a significantly positive, moderately strong relationship with the TCCI. The knowledge that climate change is entirely caused by human activities ($r = 0.182$, $p < 0.05$) or partly by human and partly by natural factors ($r = -0.177$, $p < 0.05$), and the idea of tackling it (possible [$r = 0.210$, $p < 0.01$]; not possible [$r = -0.180$, $p < 0.05$]) are also in relationship with TCCI. In terms of responsibility, believing that the Hungarian government is not doing enough to mitigate climate change ($r = -0.278$, $p < 0.01$), and that researchers and scientists bear less responsibility ($r = 0.161$, $p < 0.05$) and, in terms of lifestyle variables, the willingness to change habits ($r = 0.187$, $p < 0.01$) are in significantly weakly relationship with TCCI. Among demographic factors, gender and level of education showed a significant relationship: women ($r = 0.211$, $p < 0.01$) and college/university graduates ($r = 0.166$, $p < 0.05$) predict higher climate concern (Appendix).

The AI ($r = 0.163$, $p = 0.05$), risk perception ($r = 0.142$, $p < 0.05$) and the idea that tackling climate change is not possible ($r = -0.157$, $p < 0.05$) also have significant relationships with PEBI. In the case of the former, a positive relationship was detected, whereas in the case of the latter, a negative relationship of very weak strength was detected. The variables responsibility (county government: $r = -0.172$, $p < 0.05$) and certain willingness to change lifestyle habits ($r = 0.319$, $p < 0.01$) also have significant relationship with the development of PEBI. For lifestyle changes, we found a significantly negative relationship of very weak strength between the "probably yes" ($r = -0.195$, $p < 0.01$) and "probably not" ($r = -0.170$, $p < 0.05$) responses and the PEBI. Regarding demographic factors, only one age group, 50–64 years old ($r = 0.165$, $p < 0.05$), shows a significant, weak relationship (Appendix).

4.3. Results of regression analysis

Since several variables showed significant relationships in the correlation analysis, a multiple linear regression analysis was performed to determine the impact and relationship of selected variables on CC and PEB (Tables 2 and 3). In linear regression models, the individual impact of each demographic factor on TCCI and PEBI and also on the control variables was studied; therefore, control variables were added to Model 1 as a first step (Block 1), and demographic factors (gender, age, education) to Model 2, as a second step (Block 2). The R2 value illustrates the strength of the model relationship, namely the extent to which independent variables predict the dependent variable. The adjusted R2 value reflects the magnitude of the explanatory power (Sajtos & Mitev, 2007).

Model 2 of Table 2 shows that demographic factors only slightly moderated the impact of variables on TCCI (Block 1: adjusted $R^2 = 0.402$; Block 2: adjusted $R^2 = 0.425$). Model 2 shows that increased TCCI was clearly predicted by higher AI ($B = 0.207$, $p = 0.00$), by increased risk perception ($B = 0.520$, $p = 0.00$), and by ideas about tackling climate change, i.e. that it is possible ($B = 2.807$, $p = 0.009$) and that the government should take action against climate change ($B = 0.325$, $p = 0.014$).

Table 1. Descriptive information of variables used in statistical analysis

Variables	Question(s) used from questionnaire		Question scale/ Index scale	Mean (SD)/ Percentage
Total Climate Concern Index (TCCI)	1. How concerned are you about GW in Hungary? 2. How concerned are you about CC in Hungary? 3. Do you consider CC a serious problem?		Index derived from 3 items: Scale 3–14 (Cronbach's α = 0.841)	11.84 (2.10)
PEB Index (PEBI)	What actions do you take to combat CC? (3 – always; 2 –occasionally; 1 – would do it but don't have the opportunity; 0 – don't do it) 1. Selective waste collection 2. Buying from local/domestic producers 3. Using, buying energy efficient devices; 4. Saving water; 5. Saving gas; 6. Saving electricity; 7. Buying environmentally friendly products; 8. Planting trees; 9. Growing/breeding your own plants/animals; 10. Using renewable energy; 11. Irrigating with rainwater; 12. Walking/bicycling; 13. Using electric cars		Index derived from 13 items: Scale 0–39 (Cronbach's α = 0.659)	25.42 (477)
Attitude Index (AI)	Please, tell how much you agree with the following statements! 1. The problem of CC is extremely important to me; 2. I also need to take action on CC; 3. I am experiencing the effects of CC; 4. CC and its negative effects are inevitable; 5. I'm sure that CC is a real problem; 6. CC will have harmful effects on future generations.		Index derived from 6 items: Scale 6–30 (Cronbach's α = 0.671)	25.82 (3.34)
Risk Perception	Do you feel CC as a threat to your life at the moment?		1–5 Likert-scale (strongly disagree; strongly agree)	3.51 (1.15)
Tackling – Yes	Do you think something can be done to act against CC?		Dichotomous 0 = no, 1 = yes	Yes=95%
Tackling – No			Dichotomous 0 = no, 1 = yes	Yes=2.5%
Knowledge	What do you think is the reason for CC?	Totally caused by human activities	Dichotomous 0 = no, 1 = yes	Yes=78%
		Partly caused by artificial activities and partly by natural factors		Yes=12.5%
		Totally caused by natural factors		Yes=0.5%
		Don't know/no response		Yes=3%
		Indeterminable based on response		Yes=6%

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Responsibility	Who do you think should do the most to tackle climate change in Hungary? Please rank in order! (1. should do the most; 6. should do the least)	International organisations	Ordinal	3.63 (1.90)
		Government		2.12 (1.30)
		County government		3.77 (1.19)
		Municipality government		4.00 (1.38)
		Researchers, scientists		4.29 (1.59)
		Residents		3.19 (1.86)
Responsibility (Government)	The Hungarian government is doing everything it can to control CC.		1–5 Likert-scale (strongly disagree; strongly agree)	2.23 (1.24)
Lifestyle	Would you be willing to change your lifestyle (eating and shopping habits) in order to contribute to the fight against climate change?	Yes, definitely	Dichotomous 0 = no, 1 = yes	Yes=45%
		Probably yes		Yes=46%
		Probably not		Yes=4.5%
		Definitely not		Yes=1%
		Definitely not, because I can't afford it		Yes=3%
Female			Dichotomous 0 = no, 1 = yes	Yes=54.5%
Male				Yes=45.5%
Age 18–34				Yes=33.5%
Age 35–49				Yes=24.5%
Age 50–64				Yes=24%
Age 65+				Yes=18%
Primary school or less				Yes=4%
Vocational school				Yes=9.5%
Vocational high school				Yes=7.5%
Grammar school				Yes=21.5%
Technical school in higher education				Yes=9.5%
College/University				Yes=48%

Source: Own author's draft

The latter means that the higher number the government received compared to international organisations (i.e., the less responsibility is attributed to it), the higher the TCCI that is attributed to the individual. The belief that the Hungarian government will do everything possible to combat climate change (B = –0.400, p = 0.00) predicts a more moderate TCCI. Among demographic factors, there was no significant difference between gender and the four age groups. In terms of educational level, those with grammar school education (B = –1.060, p = 0.001) have a significantly lower TCCI than those with a college/university degree (Table 2).

Based on Model 2 in Table 3, demographic factors in this model did not modify the effect of the included variables on PEBI at all (Block 1: adjusted R^2 = 0.115; Block 2: adjusted R^2 = 0.116). Model 2 shows that opinion about tackling (B = –8.902, p = 0.003 and B = –11.484, p = 0.002) significantly negatively related to PEBI. We showed several significant results related to lifestyle. The sure willingness to change lifestyle (B = 2.279, p = 0.002) predicts a higher PEBI than those who answered "probably yes". Compared to "probably yes" respondents, "probably not" respondents (B = –5.577, p = 0.006) have a significantly lower PEBI. Among demographic

Table 2. Multiple linear regression models predicting TCCI

Block	Variables	B	SE	β	t	p
1.	(Constant)	8.523	1.600		5.325	0.000
	PEBI	0.017	0.028	0.037	0.586	0.558
	AI	0.206	0.047	0.326	4.360	0.000
	Risk Perception	0.632	0.127	0.344	4.979	0.000
	Knowledge – Partly caused by artificial activities and partly by natural factors [a]	-0.138	0.377	-0.022	-0.365	0.715
	Knowledge – Totally caused by natural factors [a]	-3.649	2.676	-0.126	-1.363	0.175
	Knowledge – Don't know/no response [a]	0.008	0.901	0.001	0.009	0.993
	Knowledge – Indeterminable based on response [a]	-0.717	0.515	-0.083	-1.394	0.165
	Tackling – Yes	2.239	1.067	0.215	2.098	0.037
	Tackling – No	1.446	1.361	0.110	1.062	0.290
	Responsibility – Government [b]	0.277	0.124	0.167	2.228	0.027
	Responsibility – County government [b]	-0.045	0.134	-0.026	-0.340	0.734
	Responsibility – Municipality government [b]	0.109	0.103	0.071	1.054	0.293
	Responsibility – Researchers, scientists [b]	0.042	0.108	0.031	0.389	0.698
	Responsibility – Residents [b]	0.035	0.088	0.030	0.396	0.692
	Responsibility (Government)	-0.377	0.110	-0.213	-3.421	0.001
	Lifestyle – Yes, definitely [c]	-0.040	0.267	-0.010	-0.150	0.881
	Lifestyle – Probably not [c]	1.096	0.657	0.105	1.669	0.097
	Lifestyle – Definitely not [c]	1.925	1.676	0.094	1.149	0.252
	Lifestyle – Definitely not, because I can't afford it [c]	0.945	0.996	0.056	0.949	0.344
	R^2	0.462				
	Adjusted R^2	0.402				
	F statistics	7.650**				
2.	(Constant)	8.521	1.602		5.318	0.000
	PEBI	0.019	0.029	0.043	0.681	0.497
	AI	0.207	0.048	0.328	4.321	0.000
	Risk Perception	0.520	0.130	0.283	3.993	0.000
	Knowledge – Partly caused by artificial activities and partly by natural factors [a]	-0.243	0.379	-0.038	-0.641	0.523
	Knowledge – Totally caused by natural factors [a]	-3.774	2.633	-0.130	-1.433	0.154
	Knowledge – Don't know/no response [a]	0.292	0.910	0.020	0.321	0.749
	Knowledge – Indeterminable based on response [a]	-0.790	0.530	-0.092	-1.491	0.138
	Tackling – Yes	2.807	1.067	0.269	2.630	0.009
	Tackling – No	2.234	1.358	0.171	1.645	0.102
	Responsibility – Government [b]	0.325	0.131	0.196	2.477	0.014
	Responsibility – County government [b]	-0.059	0.132	-0.033	-0.447	0.655
	Responsibility – Municipality government [b]	0.127	0.104	0.083	1.219	0.225
	Responsibility – Researchers, scientists [b]	0.034	0.110	0.025	0.308	0.759
	Responsibility – Residents [b]	0.050	0.089	0.044	0.562	0.575

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Responsibility (Government)	-0.400	0.112	-0.226	-3.554	0.000
Lifestyle – Yes, definitely [c]	-0.119	0.267	-0.028	-0.446	0.656
Lifestyle – Probably not [c]	0.887	0.745	0.085	1.190	0.236
Lifestyle – Definitely not [c]	2.004	1.810	0.098	1.107	0.270
Lifestyle – Definitely not, because I can't afford it [c]	0.919	1.026	0.055	0.896	0.372
Male [d]	-0.447	0.270	-0.106	-1.656	0.100
Age 18–34 [e]	-0.260	0.322	-0.059	-0.810	0.419
Age 50–64 [e]	0.161	0.375	0.033	0.429	0.668
Age 65+ [e]	-0.293	0.432	-0.052	-0.678	0.499
Primary school or less [f]	-0.472	0.794	-0.042	-0.595	0.553
Vocational school [f]	0.121	0.552	0.016	0.220	0.826
Vocational high school [f]	-0.304	0.528	-0.037	-0.575	0.566
Grammar school [f]	-1.060	0.327	-0.208	-3.239	0.001
Technical school in higher education [f]	-0.772	0.440	-0.110	-1.755	0.081
R^2	0.511				
Adjusted R^2	0.425				
F statistics	5.960**				

Source: authors' work

Note: B = Unstandardised Coefficients; SE = Standard Error of B; β = Standardised Coefficients; t = B/SE; ** $p < 0.01$, * $p < 0.05$; Reference category: a - Totally caused by human activities; b - International organisations; c - Probably yes; d - Female; e - Age 35–49; f - College/University. Predictors were mean-centred to create the interaction terms in their respective models (except dichotomous and nominal predictors).

factors, only education was significantly different in this regression model as well: those who completed vocational training (B = 3.222, p = 0.033) indicated significantly higher PEBI than those with a college/university degree (Table 3).

5. Discussion

In our work, we sought to answer the question: is there any connection between the degree of CC and PEB, and are there factors that determine the level of the CC or that lead to PEB? Based on the data of our questionnaire survey conducted in Debrecen in 2020 (N=200), we can conclude that the CC of residents is relatively high, while their PEB can only be considered moderately high. In our sample, high level of concern is associated with a lower level of willingness to act. Hidalgo-Crespo et al. (2022) showed a strong influence of environmental concern on PEB and attitudes, and Lou and Li (2023) showed a positive correlation between environmental concerns and PEB. Similar results were published by Gregersen et al. (2021), who found a significant relationship between CC and behaviours related to energy efficiency.

One of the most important results of the correlation analysis in our research was that no significant relationship was found between the CC and PEB, therefore the two were not related in our sample. This did not support Hypothesis 1, i.e. there would be a significant relationship between CC and PEB.

The correlation analysis revealed a significant, positive relationship between the CC and PEB studied: in both cases, the AI and the sure willingness to change lifestyle control variables had a relationship with the TCCI and PEBI. Our data supported Hypothesis 2, i.e. there is a significant relationship between CC, PEB and attitudes towards climate change.

The institutionalisation of environmental protection is an indicator indicating the importance of environmental and climate protection and the government's responsibility related to these in a particular country, reflected, for example, by the establishment of ministries of environment protection (Lou & Li 2023). In this regard, Hadler and Haller (2011) found that a higher level of institutionalisation in environmental protection predicted higher levels of environmental friendliness among citizens in several countries. If an individual experiences that the government is seeking environmental actions, they also tend to increase their own

Table 3. Multiple linear regression models predicting PEBI

Block	Variables	B	SE	β	t	p
1.	(Constant)	39.827	4.557		8.740	0.000
	TCCI	0.122	0.208	0.055	0.586	0.558
	AI	-0.048	0.135	-0.034	-0.355	0.723
	Risk Perception	-0.183	0.368	-0.045	-0.497	0.620
	Knowledge - Partly caused by artificial activities and partly by natural factors [a]	-0.528	1.022	-0.038	-0.517	0.606
	Knowledge - Totally caused by natural factors [a]	-8.835	7.257	-0.137	-1.217	0.225
	Knowledge - Don't know/no response [a]	-2.822	2.430	-0.087	-1.161	0.247
	Knowledge - Not be possible to decide based on the response [a]	1.980	1.394	0.103	1.420	0.157
	Tackling - Yes	-8.675	2.851	-0.373	-3.043	0.003
	Tackling - No	-11.031	3.600	-0.378	-3.064	0.003
	Responsibility - Government [b]	-0.270	0.237	-0.110	-1.142	0.255
	Responsibility - County government [b]	0.019	0.295	0.005	0.063	0.950
	Responsibility - Municipality government [b]	-0.819	0.340	-0.207	-2.407	0.017
	Responsibility - Researchers, scientists [b]	-0.271	0.349	-0.080	-0.778	0.438
	Responsibility - Residents [b]	-0.339	0.277	-0.113	-1.223	0.223
	Responsibility (Government)	0.175	0.308	0.044	0.567	0.571
	Lifestyle - Yes, definitely [c]	2.369	0.700	0.252	3.384	0.001
	Életmód - Probably no [c]	-3.499	1.772	-0.151	-1.974	0.050
	Lifestyle - Definitely not [c]	1.997	4.554	0.044	0.439	0.662
	Lifestyle - Definitely not, because I can't afford it [c]	0.450	2.703	0.012	0.166	0.868
	R^2	0.204				
	Adjusted R^2	0.115				
	F statistics	2,282**				
2.	(Constant)	37.599	4.683		8.028	0.000
	TCCI	0.148	0.218	0.067	0.681	0.497
	AI	-0.013	0.140	-0.009	-0.092	0.927
	Risk Perception	-0.033	0.377	-0.008	-0.087	0.931
	Knowledge - Partly caused by artificial activities and partly by natural factors [a]	-0.294	1.047	-0.021	-0.280	0.780
	Knowledge - Totally caused by natural factors [a]	-8.134	7.286	-0.126	-1.116	0.266
	Knowledge - Don't know/no response [a]	-3.404	2.499	-0.105	-1.362	0.175
	Knowledge - Not be possible to decide based on the response [a]	1.605	1.467	0.084	1.094	0.276
	Tackling - Yes	-8.902	2.925	-0.383	-3.043	0.003
	Tackling - No	-11.484	3.669	-0.394	-3.130	0.002
	Responsibility - Government [b]	-0.119	0.245	-0.048	-0.487	0.627
	Responsibility - County government [b]	0.118	0.317	0.032	0.371	0.711
	Responsibility - Municipality government [b]	-0.657	0.351	-0.167	-1.872	0.063
	Responsibility - Researchers, scientists [b]	-0.194	0.355	-0.057	-0.547	0.585
	Responsibility - Residents [b]	-0.363	0.279	-0.121	-1.299	0.196
	Responsibility (Government)	0.082	0.322	0.021	0.254	0.800

continouation of Table 3 on the next page

Lifestyle - Yes, definitely [c]	2.279	0.715	0.243	3.187	0.002
Életmód - Probably no [c]	-5.577	2.019	-0.240	-2.762	0.006
Lifestyle - Definitely not [c]	2.603	5.011	0.057	0.519	0.604
Lifestyle - Definitely not, because I can't afford it [c]	1.162	2.837	0.031	0.410	0.683
Male [d]	0.965	0.748	0.103	1.290	0.199
Age 18–34 [e]	-0.584	0.888	-0.054	-0.657	0.512
Age 50–64 [e]	0.323	0.973	0.030	0.332	0.741
Age 65+ [e]	0.070	1.126	0.006	0.063	0.950
Primary school or less [f]	-0.220	2.195	-0.009	-0.100	0.920
Vocational school [f]	3.222	1.502	0.192	2.146	0.033
Vocational high school [f]	1.023	1.457	0.055	0.702	0.484
Grammar school [f]	0.662	0.931	0.058	0.710	0.479
Technical school in higher education [f]	1.179	1.223	0.076	0.964	0.336
R^2	0.247				
Adjusted R^2	0.116				
F statistics	1,878**				

Source: authors' work

Note: B = Unstandardized Coefficients; SE = Standard Error of B; β = Standardized Coefficients; t = B/SE; ** p < 0.01, * p < 0.05; Reference category: a - Totally caused by human activities; b - International organisations; c - Probably yes; d - Female; e - Age 35-49; f - Collage/University. Predictors were mean-centered to create the interaction terms in their respective models (except dichotomous and nominal predictors).

environmental responsibility (Hidalgo-Crespo et al., 2022). People accept PEB when they see evidence of its usefulness (Lin, 2013). Compared to the rest of Europe, Central and Eastern Europe has the lowest proportion of people who consider climate change mitigation to be their responsibility. Hungary has not had an independent ministry for the environment for more than a decade, but there is a high level of concern among Hungarians, however, this is associated with low personal responsibility and willingness to act (Bodor & Grünhut, 2021). There is reason to believe that concern motivates people to do pro-environmental actions (van der Linden, 2017), however, the belief that an individual's actions are insignificant can hold back personal commitment (Gregersen et al., 2021).

The "opinion on the tackling" variable was also significant in both cases. The belief that nothing can be done about climate change showed a positive relationship with TCCI and a negative relationship with PEBI . Among demographic factors, gender and educational level were significantly associated with concern: women and college/university education predict higher climate concern. In terms of behaviour, only age showed a significant relationship: those aged 50-64 years had a higher PEBI. Hypothesis 3 was confirmed by the results, i.e. the sense of responsibility for climate change is in association with PEB while the sense of threat is associated with CC, but it can be stated that the sense of responsibility was also in relationship with concern, while the sense of threat was also in relationship with PEB.

In the regression analyses, demographic factors only slightly moderated the impact of variables on the two indices studied. Only one variable was significant in both cases in the regression models: the opinion on the combat, namely that it was possible to take action to mitigate climate change, which showed a positive relationship with TCCI and a negative relationship with PEBI. In the case of the concern-dependent variable, the attitude, risk perception and sense of responsibility variables were significant, while the behaviour-dependent variable was significantly influenced by lifestyle-independent variables. Among demographic factors, no differences were detected between gender and the four age groups in any of the cases. In terms of educational level, those with grammar school education had significantly lower TCCI than those with college/university education. In addition, those who have vocational school education show significantly higher PEBI than those with college/university education. Our preliminary hypothesis (Hypothesis 4), i.e. demo-

graphic indicators (gender, age, highest level of education) have a significant impact on both CC and PEB-action was partly verified and action as only educational level was partially significant in the regression models.

Publications studying the relationship between environmental concern and PEB generally show a low correlation between the two, to which the literature refers as the "environmental concern-behaviour gap" (e.g. Tam & Chan 2017, 2018). Of course, studies can be found which refute the previous finding, such as Lou and Li (2023), who show a positive correlation between environmental concerns and PEB. Our results support and confirm studies that show that an individual's CC does not consistently result in PEB (Kollmuss & Agyeman 2002; Tam & Chan 2017) and contradictory to studies finding the opposite (Whitmarsh et al. 2022; Lou & Li 2023). According to Berthold et al. (2023), the willingness to behave in a pro-environmental way is lower among those with higher income, and subjective financial scarcity is associated with a decrease in PEB. Overall, women, younger people, those with higher levels of education, and those who are in better economic situation are more likely to take environment- and climate-friendly measures (Beiser-McGrath & Huber 2018). Gregersen et al. (2021) also showed a significant relationship between behaviour related to energy efficiency and demography: women, older people, those with higher income and those with higher levels of education are more likely to exhibit PEB.

Our research results confirm the finding that educational level makes a difference in the degree of CC (Shi et al. 2016; Beiser-McGrath & Huber 2018; Gregersen et al. 2021). Our results are in line with the data of Weckroth and Ala-Mantila (2022) showing that attitudes towards climate change and energy-saving behaviour are strongly influenced by the level of education and the so-called socio-economic disadvantage (lower level of education, lower income). In our case, surprisingly, college education was associated with a lower PEBI than vocational education.

6. Limitations and future directions

Based on the relationships and information identified, we believe that further research is needed at both municipal and national level to understand and identify in more detail the characteristics and correlations between the two above mentioned factors. Regular representative municipal research may also include time-series analyses that would study the data of several consecutive years, in order to obtain results that are even more comprehensive. Since the environmental problems of our study area, the city of Debrecen, are similar in many respects to the problems of most major cities in the post-socialist region of Central and Eastern Europe. The data collection methodology and statistical data analysis methods applied here can be used and applied in other places as well. Our research results can provide a basis for designing more effective adaptation strategies at local level, which can be achieved through a change in attitude, therefore related to PEB.

It is important to emphasize that our research has time and space limitations. Our data refer to 2020, but the literature results used may include a different period. Furthermore, our results focused on Debrecen, but different results may occur in other areas of the country, as well as in and around the capital, Budapest.

7. Conclusions

The study analysed the pivotal factors of CC and PEB among Debrecen's urban population in Hungary, thus enriching the related literature. Our research highlights the complexity of the relationship between climate concern and pro-environmental behavior. Although a relatively high level of climate concern was observed among the surveyed population in Debrecen, this did not translate into a similarly high level of pro-environmental behavior, confirming the existence of the well-documented environmental concern-behavior gap. Additionally, demographic variables, particularly educational level, influenced climate concern and, to a lesser extent, behavior. These factors are critical in shaping environmental attitudes and actions. Addressing the concern-behavior gap requires targeted interventions that raise awareness and foster a sense of efficacy and responsibility among individuals.

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Appendix

Variables	1	2	3	4	5	6	7	8	9	10	11
1. Total Climate Concern Index	-										
2. PEB Index	0.078	-									
3. Attitude Index	,465**	,163*	-								
4. Risk Perception	,467**	,142*	,448**	-							
5. Knowledge - Totally caused by human activities	,182*	0.021	0.128	0.095	-						
6. Knowledge - Partly caused by artificial activities and partly by natural factors	-,177*	-0.064	-,219**	-,144*	-,712**	-					
7. Knowledge - Totally caused by natural factors	-0.126	-0.115	-0.124	-0.119	-0.133	-0.027	-				
8. Knowledge - Don't know/no response	-0.080	-0.050	0.014	-0.043	-,331**	-0.066	-0.012	-			
9. Knowledge - Not be possible to decide based on the response	0.022	0.123	0.108	0.102	-,476**	-0.095	-0.018	-0.044	-		
10. Tackling - Yes	,210**	0.088	0.096	,142*	,210**	-0.052	-,309**	-,363**	0.058	-	
11. Tackling - No	-,180*	-,157*	-0.077	-0.137	-0.070	0.036	,443**	-0.028	-0.040	-,698**	-
12. Responsibility - International organisations	-0.086	0.051	-0.055	-0.060	0.043	0.052	0.043	-0.068	-0.116	0.039	-0.079
13. Responsibility - Government	0.012	0.076	-0.033	-0.074	-0.121	-0.023	0.017	0.083	,182*	-0.118	0.044
14. Responsibility - County government	-0.120	-,172*	-0.104	-,147*	-0.117	0.069	-0.051	0.056	0.085	-0.088	0.067
15. Responsibility - Municipality government	0.011	-0.100	-0.031	-0.057	-0.059	-0.004	-0.002	0.047	0.077	-0.052	0.049
16. Responsibility - Researchers, scientists	,161*	0.021	,182*	,196**	0.045	0.037	-0.119	-0.078	-0.044	0.131	-0.045
17. Responsibility - Residents	0.018	0.025	-0.001	0.090	0.052	-0.077	0.102	0.009	-0.018	0.022	0.050
18. Responsibility (Government)	-,278**	-0.012	-0.079	-,155*	-0.040	0.012	-0.079	,188**	-0.047	-,189**	0.117
19. Lifestyle - Yes, definitely	,187**	,319**	,275**	,202**	0.044	-0.068	-0.064	0.077	-0.017	0.115	-0.080
20. Lifestyle - Probably yes	-0.112	-,195**	-,173*	-0.075	-0.043	0.106	-0.065	-0.104	0.020	0.028	-0.019
21. Lifestyle - Probably no	-0.128	-,170*	-0.123	-,140*	0.057	-0.009	-0.015	-0.038	-0.055	-,172*	0.120
22. Lifestyle - Definitely not	-0.064	-0.075	-0.069	-0.118	-0.068	-0.038	,705**	-0.018	-0.025	-,208**	,306**
23. Lifestyle - Definitely not, because I can't afford it	0.014	-0.089	-0.064	-,174*	-0.048	-0.066	-0.012	,141*	0.079	-0.094	-0.028
24. Female	,211**	-0.017	,215**	,214**	0.072	-,140*	-0.078	-0.016	0.104	0.067	-0.111
25. Age 18–34	0.005	-0.078	-0.020	-0.016	0.070	0.020	-0.050	-0.001	-0.135	0.017	-0.046
26. Age 35-49	0.035	-0.070	-0.016	0.052	-0.090	0.136	-0.040	0.036	-0.046	0.024	-0.091
27. Age 50-64	0.066	,165*	0.045	0.078	0.044	-0.035	-0.040	-0.099	0.055	-0.032	0.060
28. Age 65+	-0.122	-0.009	-0.007	-0.125	-0.034	-0.138	,151*	0.070	,156*	-0.012	0.092
29. Primary school or less	-0.045	-0.101	-0.074	-0.130	0.047	-0.077	,347**	-0.036	-0.052	-0.070	0.131
30. Vocational school	-0.070	0.068	-0.088	-0.051	0.007	-0.071	-0.023	,143*	-0.010	-,160*	0.057
31. Vocational high school	0.041	0.048	,162*	-0.004	-0.078	-0.050	-0.020	0.061	,168*	0.065	-0.046
32. Grammar school	-0.135	-0.016	-0.006	-0.087	0.014	-0.051	-0.037	0.051	0.022	-0.047	0.072
33. Technical school in higher education	-0.032	0.030	-0.002	-0.043	0.049	-0.019	-0.023	-0.057	-0.010	0.074	-0.052
34. College/University	,166*	-0.030	0.007	,180*	-0.021	,151*	-0.068	-0.110	-0.074	0.083	-0.090

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Source: authors' work
Note: ** $p < 0.01$; * $p < 0.05$.

Variables	12	13	14	15	16	17	18	19	20	21
1. Total Climate Concern Index										
2. PEB Index										
3. Attitude Index										
4. Risk Perception										
5. Knowledge - Totally caused by human activities										
6. Knowledge - Partly caused by artificial activities and partly by natural factors										
7. Knowledge - Totally caused by natural factors										
8. Knowledge - Don't know/no response										
9. Knowledge - Not be possible to decide based on the response										
10. Tackling - Yes										
11. Tackling - No										
12. Responsibility - International organisations	-									
13. Responsibility - Government	-,143*	-								
14. Responsibility - County government	-,333**	,204**	-							
15. Responsibility - Municipality government	-,567**	-0.064	,441**	-						
16. Responsibility - Researchers, scientists	0.011	-,154*	-,482**	-,372**	-					
17. Responsibility - Residents	-,386**	-,447**	-,266**	0.030	-,174*	-				
18. Responsibility (Government)	-0.044	,189**	0.100	-0.055	-,191**	0.036	-			
19. Lifestyle - Yes, definitely	0.037	-0.028	-0.065	-0.043	0.069	-0.024	-0.049	-		
20. Lifestyle - Probably yes	-0.074	0.060	0.083	0.070	-0.022	-0.029	-0.035	-,835**	-	
21. Lifestyle - Probably no	0.028	-0.096	0.013	-0.027	-0.021	0.041	0.128	-,196**	-,200**	-
22. Lifestyle - Definitely not	0.097	-0.039	0.021	-0.003	-,152*	0.074	-0.014	-0.091	-0.093	-0.022
23. Lifestyle - Definitely not, because I can't afford it	0.017	0.057	-0.095	-0.055	-0.028	0.075	0.074	-,159*	-,162*	-0.038
24. Female	-0.029	,246**	0.017	0.000	0.016	-0.116	-0.025	0.019	-0.023	-0.044
25. Age 18–34	-0.055	0.070	0.119	0.125	-0.046	-0.089	-,153*	-0.067	0.110	-0.052
26. Age 35-49	,145*	-0.049	0.068	-0.081	-0.049	-0.067	-0.058	0.069	-0.013	-0.124
27. Age 50-64	-0.057	-0.071	-,182*	-0.016	0.132	0.084	0.024	0.033	-0.002	-0.009
28. Age 65+	-0.029	0.047	-0.018	-0.047	-0.037	0.089	,225**	-0.031	-0.119	,212**
29. Primary school or less	0.080	-0.092	0.057	0.077	-,171*	0.037	-0.023	-0.031	-0.137	-0.044
30. Vocational school	-0.063	-0.052	-0.021	-0.061	0.041	0.102	,206**	-0.019	-,196**	,505**
31. Vocational high school	-0.098	0.056	-0.108	-0.050	0.060	0.104	0.037	0.010	0.004	-0.062
32. Grammar school	-0.011	,190**	0.040	0.021	-0.053	-0.092	0.033	-0.009	0.054	-0.055
33. Technical school in higher education	-0.115	-0.007	-0.056	0.059	0.027	0.045	-0.078	-0.087	,146*	-0.070
34. College/University	0.137	-0.118	0.048	-0.019	0.036	-0.078	-0.113	0.076	0.037	-,160*

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Source: authors' work
Note: ** $p < 0.01$; * $p < 0.05$.

Variables	22	23	24	25	26	27	28	29	30	31	32	33
1. Total Climate Concern Index												
2. PEB Index												
3. Attitude Index												
4. Risk Perception												
5. Knowledge - Totally caused by hum activities												
6. Knowledge - Partly caused by artific activities and partly by natural factors												
7. Knowledge - Totally caused by natu factors												
8. Knowledge - Don't know/no respon												
9. Knowledge - Not be possible to deci based on the response												
10. Tackling - Yes												
11. Tackling - No												
12. Responsibility - International organisations												
13. Responsibility - Government												
14. Responsibility - County governme												
15. Responsibility - Municipality government												
16. Responsibility - Researchers, scient												
17. Responsibility - Residents												
18. Responsibility (Government)												
19. Lifestyle - Yes, definitely												
20. Lifestyle - Probably yes												
21. Lifestyle - Probably no												
22. Lifestyle - Definitely not	-											
23. Lifestyle - Definitely not, because I can't afford it	0.018	-										
24. Female	-0.009	0.043	-									
25. Age 18–34	-0.071	-0.063	-0.054	-								
26. Age 35-49	-0.057	0.036	-0.040	-,404**	-							
27. Age 50-64	-0.056	-0.030	0.020	-,399**	-,320**	-						
28. Age 65+	,215**	0.070	0.088	-,333**	-,267**	-,263**	-					
29. Primary school or less	,492**	,263**	0.135	-0.037	0.002	-0.055	0.104	-				
30. Vocational school	-0.033	0.043	-0.012	-,158*	-,145*	0.097	,248**	-0.066	-			
31. Vocational high school	-0.029	0.061	-0.083	-0.081	-0.118	,151*	0.064	-0.058	-0.092	-		
32. Grammar school	-0.053	-0.021	0.136	-0.010	-0.100	0.048	0.072	-0.107	-,170*	-,149*	-	
33. Technical school in higher educati	0.033	-0.057	-0.012	-0.122	0.014	,177*	-0.063	-0.066	-0.105	-0.092	-,170*	-
34. College/University	-0.097	-0.110	-0.107	,230**	,221**	-,259**	-,242**	-,196**	-,311**	-,274**	-,503**	-,311**

Source: authors' work
Note: ** p < 0.01; * p < 0.05.