

One Earth, Volume 6

Supplemental information

**Social media data shed light
on air-conditioning interest of heat-vulnerable
regions and sociodemographic groups**

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Supplemental Information

Supplemental Figures

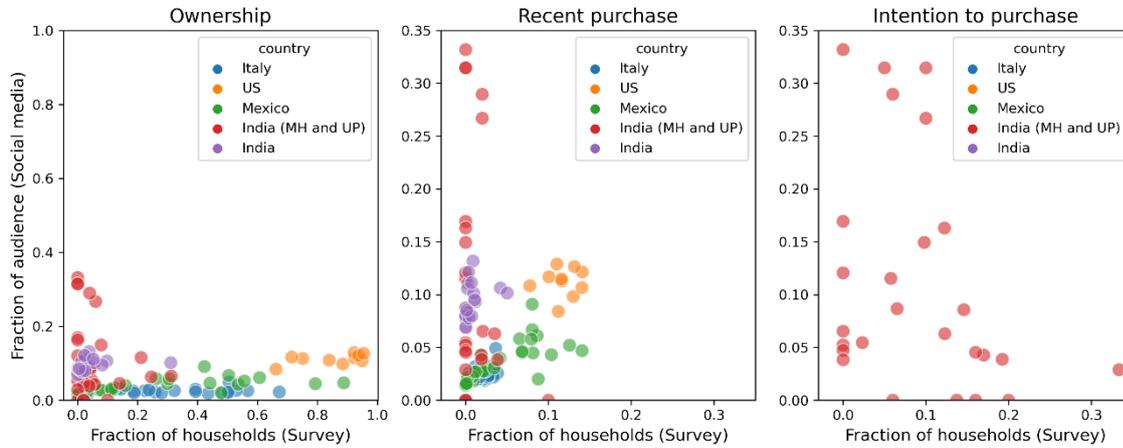


Figure S1: Social media audience fraction interested in air conditioning (y-axis) vs fraction of households who own, have recently purchased or are intending to purchase air-conditioning (x-axis). Each dot refers to a state, division, or semi-urban town, depending on the location unit of the corresponding survey indicated by color-coding. Ownership rates exceeds the online interest in air-conditioning, which can be explained by the assumption that households with an AC unit would not engage in online activity for instance for buying an AC unit. Online interest in air-conditioning better correlates with the recent purchases of AC, except in the semi-urban towns of Maharashtra and Uttar Pradesh states of India, where the social media data significantly exceed purchase rates. In these towns, the fraction of households who reported intention to purchase is in a similar order of magnitude with a higher correlation to the social media audience fraction interested in air conditioning.

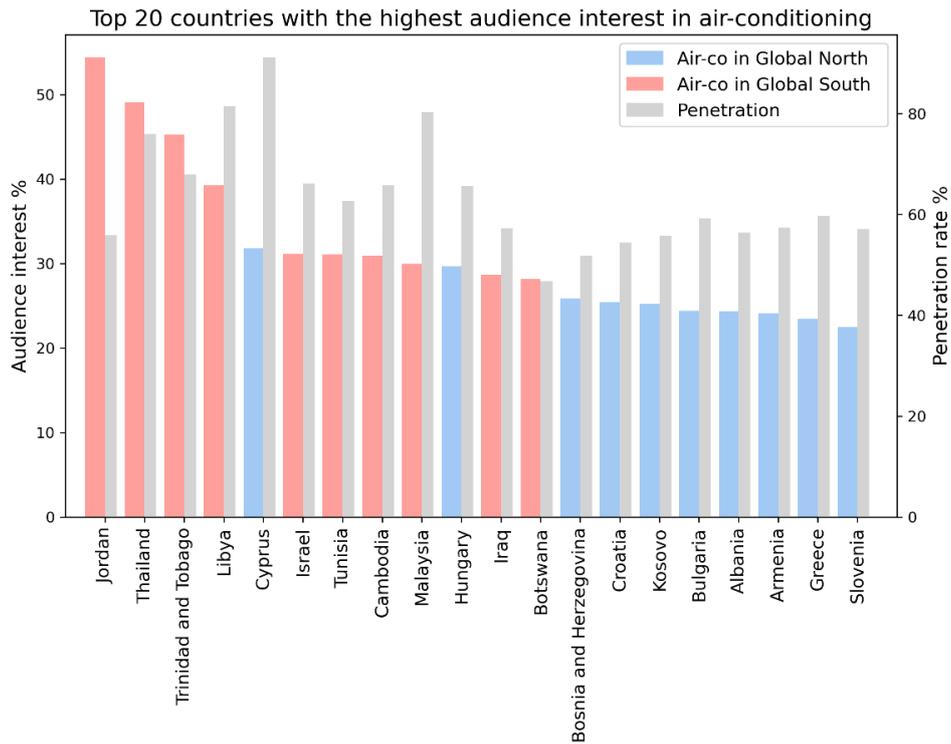


Figure S2: Top 20 countries with the highest air-conditioning interest (left y-axis) on Facebook and Instagram, and the penetration rates (right y-axis) of social media with respect to the total population. Complementing Figure 3, this figure shows the top 20 countries in terms of the fraction of Facebook and Instagram audience interested in air-conditioning, ordered from left to right. For each country, the red or blue bar shows the audience fraction, color denoting whether it is a Global North or Global South country. The grey bars show the penetration rates (population active on Facebook and Instagram) across these countries aligned with the right-hand-side axis.

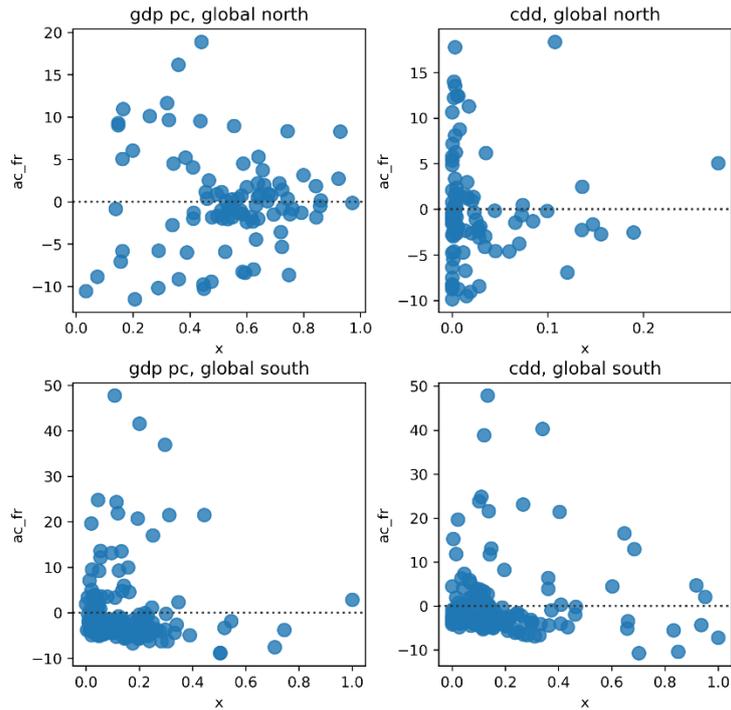


Figure S3: Residues of linear regression shown in Fig. 3g-h in Global North and South. The independent variable of the regression is the social media audience fraction interested in AC (*ac_fr*) and the dependent variable is GDP per capita (*gdp pc*) or cooling degree days (*cdd*). The scattered residuals indicate that any other form of regression, such as polynomial or logistic, does not represent the distribution of data better.

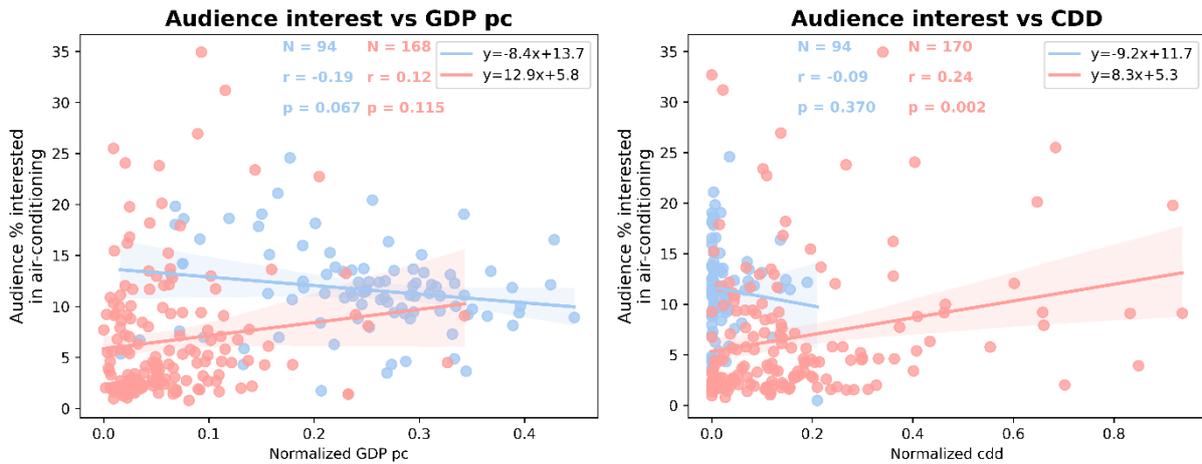


Figure S4: Linear regression between the audience interest percentage, and the normalized GDP per capita (left) and cooling degree days (CDD, right) after the outliers, that is, the values higher than the 99th quantile on both x and y axes are removed. Compared to Figure 3g and h, where the regression on the full data set is reported, the direction of relationship does not change, yet the statistical significance becomes less. In other words, the positive linear relationship between the audience interested in air-conditioning and GDP per capita in the Global South is not statistically significant, so as the negative linear relationship between the audience interest and CDD in the Global North.

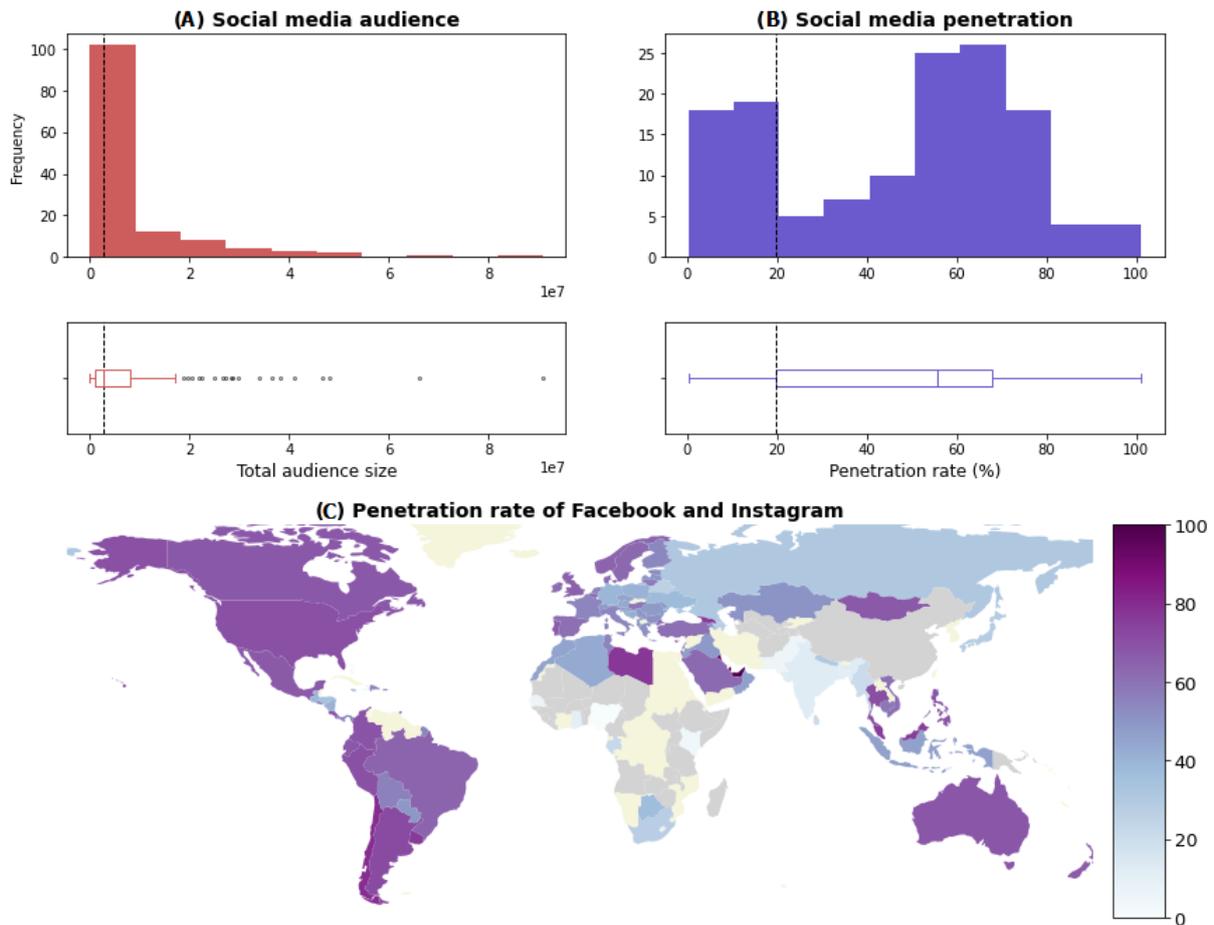


Figure S5: Audience size and penetration rates of Facebook and Instagram. (A) Distribution of the audience size across 136 countries in a histogram plot (top) and in an aligned boxplot (bottom). The vertical dashed line shows the 1st quartile at 916,652. The countries with lower audience sizes are excluded. (B) Distribution of the penetration rate, vertical dashed line showing the 1st quartile at 19.8%. (C) Global map color-coded according to the penetration rates across 136 countries. The countries in light yellow are the ones for which there is no social media data available. The countries in grey are the ones excluded from our analysis due to low penetration rate and audience size, i.e. those to the left of the dashed vertical lines in (A) and (B).

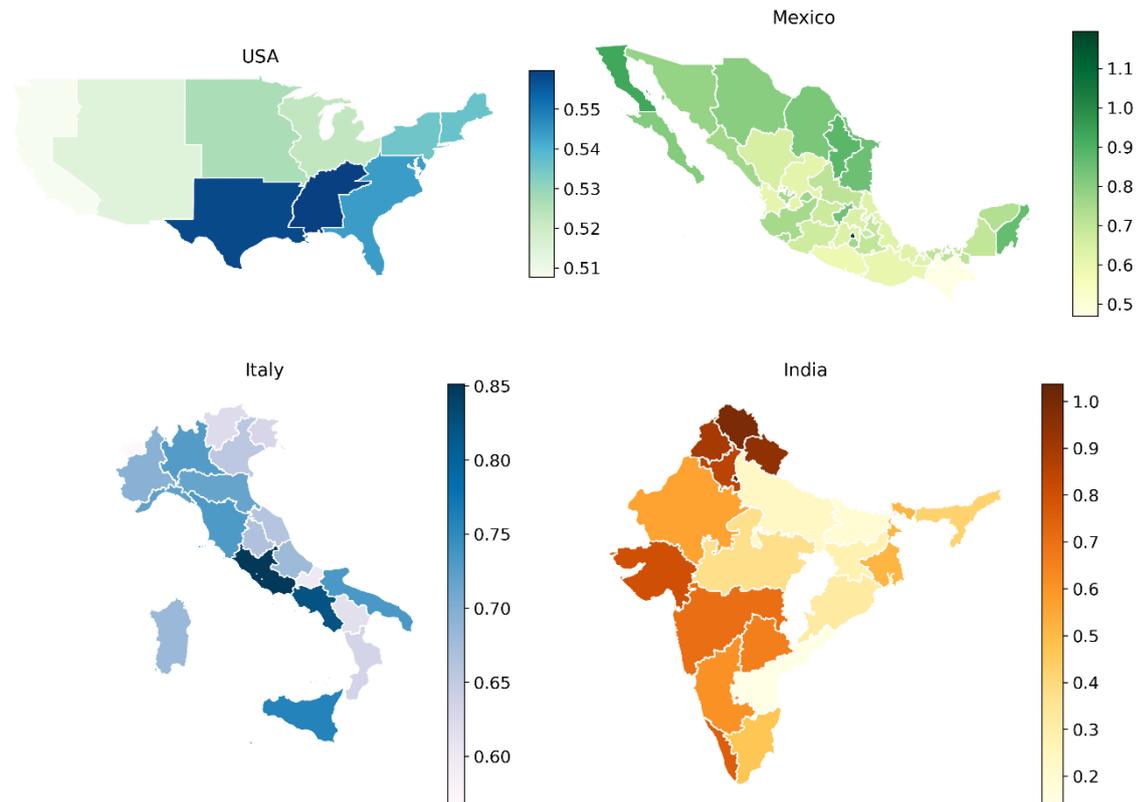


Figure S6: Penetration rates in the four countries across regions or states. (a) Across 11 regions of US, the average penetration rate (fraction of the population who is active on Facebook and Instagram) is 53% (50.7 – 56%). The country-level penetration rate is much higher due to mobility and change in location settings on user profiles. (b) Across 32 states of Mexico, the average penetration rate is 73.9% (46.9 – 119%). The penetration rate being higher than 100% in Mexico city is attributed to recent permanent or temporary population mobility. (c) In Italy, the average penetration rate across 20 regions is 68.8% (56.8 – 85.1%). (d) Across 21 states of India, the average penetration rate is 36.4% (14 – 103%). More than 100% social media penetration is attributed to population increase and mobility in Delhi.

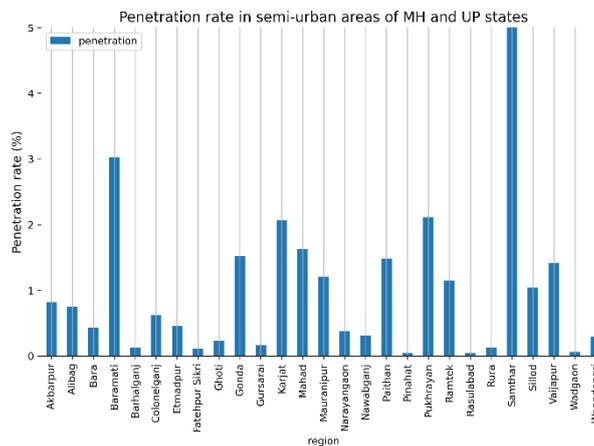


Figure S7: Penetration rates in the four countries across 27 semi-urban areas in the Maharashtra and Uttar Pradesh states of India. These penetration rates are calculated with respect to the current (June 2021) social media audience and the estimated population of each town. The population estimate is the actual population of each town in 2011 Census data, adjusted according to the national population increase of India between 2011 and 2021 (11.4%) United Nations, Department of Economic and Social Affairs, Population Division. World Population Prospects: The 2019 Revision.

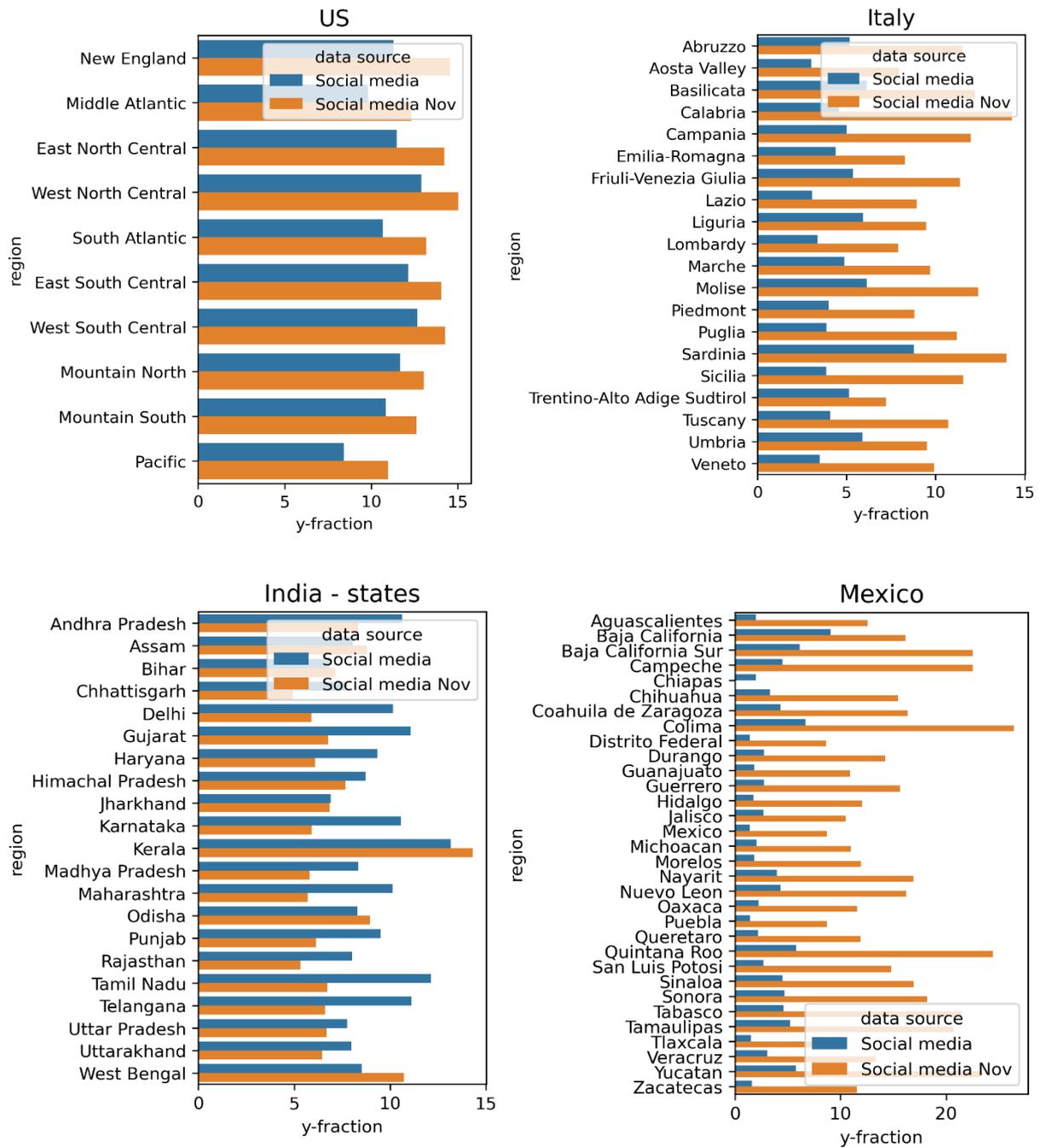


Figure S8: Comparison of the audience fraction interested in air-conditioning in May-September 2021 (blue) and November 2022 (orange). The bars refer to the percentage of social media audience fraction interested in air-conditioning in the divisions or states of the four countries.

Supplemental Tables

Table S1: List of Global North and Global South countries

Global North (GN) countries	Global South (GS) countries
Albania, Bulgaria, Bosnia and Herzegovina, Czech Republic, Estonia, Croatia, Hungary, Lithuania, Latvia, The former Yugoslav Republic of Macedonia, Montenegro, Poland, Romania, Serbia, Slovakia, Slovenia, Kosovo, Armenia, Azerbaijan, Belarus, Georgia, Kazakhstan, Kyrgyzstan, Moldova, Russia, Tajikistan, Turkmenistan, Ukraine, Uzbekistan, Canada, Puerto Rico, United States, Australia, Japan, New Zealand, Andorra, Austria, Belgium, Switzerland, Cyprus, Germany, Denmark, Spain, Finland, France, United Kingdom, Greece, Ireland, Iceland, Italy, Liechtenstein, Luxembourg, Malta, Netherlands, Norway, Portugal, Sweden, Turkey	Angola, Burundi, Benin, Burkina Faso, Botswana, Central African Republic, Cote d'Ivoire, Cameroon, Democratic Republic of the Congo, Congo, Comoros, Cape Verde, Djibouti, Eritrea, Western Sahara, Ethiopia, Gabon, Ghana, Guinea, Gambia, Guinea-Bissau, Equatorial Guinea, Kenya, Liberia, Lesotho, Madagascar, Mali, Mozambique, Mauritania, Mauritius, Malawi, Namibia, Niger, Nigeria, Rwanda, Senegal, Sierra Leone, Somalia, Swaziland, Seychelles, Chad, Togo, Tanzania, Uganda, South Africa, Zambia, Zimbabwe, China, Cambodia, Lao People's Democratic Republic, Mongolia, Dem People's Rep of Korea, Vietnam, Argentina, Antigua and Barbuda, Belize, Bolivia, Brazil, Barbados, Chile, Colombia, Costa Rica, Cuba, Dominica, Dominican Republic, Ecuador, Grenada, Guatemala, French Guiana, Guyana, Honduras, Haiti, Jamaica, Saint Kitts and Nevis, Saint Lucia, Mexico, Nicaragua, Panama, Peru, Paraguay, El Salvador, Sao Tome and Principe, Suriname, Trinidad and Tobago, Uruguay, Saint Vincent and the Grenadines, Venezuela, United Arab Emirates, Bahrain, Algeria, Egypt, Iran (Islamic Republic of), Iraq, Israel, Jordan, Kuwait, Lebanon, Libya, Morocco, Oman, Palestinian Territories, Qatar, Saudi Arabia, South Sudan, Syrian Arab Republic, Tunisia, Yemen, Brunei Darussalam, Fiji, Indonesia, Republic of Korea, Myanmar, Malaysia, Philippines, Papua New Guinea, Singapore, Thailand, Timor-Leste, Taiwan, Vanuatu, Afghanistan, Bangladesh, Bhutan, India, Sri Lanka, Maldives, Nepal, Pakistan

Table S2: Summary statistics of the social media audience fraction interested in air-conditioning across 113 countries (as the average of two data collection points in two seasons) and the states of US, India, Brazil, and Mexico

Attribute	Range	Region	mean	median	q25	q75	std	n
Gender	female	Global North	11.74	10.99	5.80	15.97	7.01	46
Gender	both	Global North	12.47	11.89	7.13	17.53	6.24	46
Gender	male	Global North	14.14	13.88	8.34	19.01	6.47	46
Gender	female	Global South	11.98	9.93	6.13	14.81	8.70	68
Gender	both	Global South	13.07	10.62	7.88	15.48	8.67	68
Gender	male	Global South	14.15	12.01	9.15	17.10	8.90	68
Gender	female	All countries	11.88	10.64	5.95	15.49	8.03	114
Gender	both	All countries	12.83	11.20	7.69	16.59	7.76	114
Gender	male	All countries	14.15	13.05	8.78	17.92	7.98	114
Age	65-65+	Global North	14.59	13.65	8.70	18.85	7.10	43

Age	18-34	Global North	9.85	8.53	5.22	12.52	6.48	45
Age	35-64	Global North	16.75	15.24	11.13	23.57	8.22	43
Age	65-65+	Global South	14.29	12.89	8.60	18.15	8.53	64
Age	18-34	Global South	10.80	8.28	5.73	13.73	7.72	68
Age	35-64	Global South	16.57	13.08	9.78	20.15	11.03	68
Age	65-65+	All countries	14.41	13.15	8.58	18.34	7.95	107
Age	18-34	All countries	10.42	8.39	5.30	13.64	7.24	113
Age	35-64	All countries	16.64	14.11	10.17	23.44	9.99	111
Education	3 Bachelors	Global North	15.36	13.76	10.89	19.54	7.66	45
Education	1 Less than high school	Global North	12.91	12.43	9.43	16.21	6.07	46
Education	2 High school	Global North	14.19	13.32	9.82	18.05	6.81	46
Education	4 Masters and PhD	Global North	14.57	12.60	7.51	19.14	8.30	46
Education	3 Bachelors	Global South	16.49	13.62	9.05	20.23	10.81	68
Education	1 Less than high school	Global South	15.03	11.52	7.98	18.00	10.28	68
Education	2 High school	Global South	14.16	11.30	7.81	17.29	9.71	67
Education	4 Masters and PhD	Global South	18.88	14.49	11.46	22.75	12.52	68
Education	3 Bachelors	All countries	16.04	13.63	9.36	20.02	9.66	113
Education	1 Less than high school	All countries	14.18	11.93	8.22	16.92	8.86	114
Education	2 High school	All countries	14.17	12.60	8.05	17.70	8.61	113
Education	4 Masters and PhD	All countries	17.14	14.10	10.29	21.20	11.17	114
Relationship	all	Global North	18.21	16.50	12.88	22.03	7.66	46
Relationship	married or living together	Global North	26.36	25.18	18.44	31.66	10.98	46
Relationship	all	Global South	16.11	15.67	11.24	19.88	7.93	68
Relationship	married or living together	Global South	25.88	24.65	18.55	30.75	12.06	67
Relationship	all	All countries	16.95	16.11	11.96	20.71	7.85	114
Relationship	married or living together	All countries	26.07	24.90	18.33	31.11	11.58	113
Family	all	Global North	18.30	16.79	12.64	22.32	7.68	45
Family	parents of 9-18 yrs old	Global North	37.96	35.18	23.87	51.21	17.10	44
Family	parents of 0-8 yrs old	Global North	42.56	39.68	22.49	56.92	22.67	45
Family	all	Global South	18.10	17.94	13.14	20.94	7.60	49
Family	parents of 9-18 yrs old	Global South	46.35	42.43	36.72	54.17	15.33	49
Family	parents of 0-8 yrs old	Global South	49.58	45.69	34.34	61.68	19.41	48
Family	all	All countries	18.20	17.31	13.06	21.15	7.60	94
Family	parents of 9-18 yrs old	All countries	42.38	41.44	29.90	53.54	16.64	93
Family	parents of 0-8 yrs old	All countries	46.18	43.95	29.60	60.69	21.23	93

Table S3: List of the countries in three regions with high AC interest

Eastern Europe (EEU)	Middle East and North Africa (MEA)	Pacific Asia (PAS)
Albania	United Arab Emirates	Brunei Darussalam
Bulgaria	Bahrain	Fiji
Bosnia and Herzegovina	Algeria	Indonesia
Czech Republic	Egypt	Republic of Korea
Estonia	Iraq	Myanmar

Croatia	Israel	Malaysia
Hungary	Jordan	Philippines
Lithuania	Kuwait	Papua New Guinea
Latvia	Lebanon	Singapore
Montenegro	Morocco	Thailand
Poland	Oman	Taiwan
Romania	Qatar	Vanuatu
Serbia	Saudi Arabia	
Slovakia	Syrian Arab Republic	
Slovenia	Tunisia	
	Yemen	
	South Sudan	

Table S4: Summary statistics of the social media audience fraction interested in air-conditioning (as the average of two data collection points in two seasons) in Eastern Europe (EEU), Middle East and North Africa (MEA) and Pacific Asia (PAS)

Attribute	Range	Region	mean	median	q25	q75	std	n
Gender	female	EEU	15.3222	15.02516	10.78096	17.62081	6.629055	14
Gender	both	EEU	16.02535	17.22459	13.13131	18.63426	4.134078	14
Gender	male	EEU	18.68751	19.3623	15.62274	21.48043	4.715704	14
Gender	female	PAS	16.64649	17.61911	9.721581	20.25512	11.44363	7
Gender	both	PAS	17.47869	18.18983	10.70603	22.44923	11.07297	7
Gender	male	PAS	18.35244	18.65056	11.50324	25.09163	10.99805	7
Gender	female	MEA	15.03659	12.31956	6.834755	19.91974	10.57124	14
Gender	both	MEA	17.39975	15.11852	9.122109	22.08414	10.54707	14
Gender	male	MEA	18.98919	16.38359	10.42102	23.60485	10.68837	14
Gender	female	AFR	10.52733	7.786258	6.809199	11.57027	7.518428	17
Gender	both	AFR	11.3309	9.405761	8.604397	12.04493	7.41771	17
Gender	male	AFR	12.56063	10.77681	9.981157	13.34467	7.805682	17
Age	65-65+	EEU	17.02921	16.96252	12.82667	21.21374	6.113819	13
Age	18-34	EEU	14.91802	14.36054	9.008085	17.80458	7.540613	14
Age	35-64	EEU	21.1454	23.58618	15.80149	25.35764	6.922394	14
Age	65-65+	PAS	18.69978	22.20893	16.58139	23.37018	8.167831	7
Age	18-34	PAS	14.88311	14.77983	8.906887	18.11138	10.2965	7
Age	35-64	PAS	23.55605	27.83778	16.1671	29.64825	13.01667	7
Age	65-65+	MEA	20.28731	19.99453	12.29995	24.54497	10.67582	12
Age	18-34	MEA	14.17345	12.42915	7.205446	17.9456	8.993583	14
Age	35-64	MEA	23.27403	18.51646	12.28947	28.47226	13.95399	14
Age	65-65+	AFR	12.90335	12.91657	7.057524	14.61266	8.185631	17
Age	18-34	AFR	8.887124	8.164638	4.382568	8.413432	7.161216	17
Age	35-64	AFR	12.34479	10.69346	7.047403	12.95708	8.489357	17
Education	3 Bachelors	EEU	19.71349	19.75424	13.77672	23.31429	7.30674	14
Education	2 High school	EEU	18.48616	18.53225	13.78849	21.72044	6.408485	14
Education	1 Less than high school	EEU	16.3626	15.74665	12.69989	19.64605	5.859734	14
Education	4 Masters and PhD	EEU	19.29521	17.54113	13.74768	25.11299	8.31389	14
Education	3 Bachelors	PAS	23.38674	27.90747	14.74571	29.96211	13.99643	7
Education	2 High school	PAS	19.06939	22.73372	10.1226	25.05622	12.28364	7
Education	1 Less than high school	PAS	21.312	19.995	16.1981	26.42205	12.06555	7
Education	4 Masters and PhD	PAS	27.27045	27.80688	14.9629	39.17363	17.67128	7
Education	3 Bachelors	MEA	22.41786	21.53017	14.33925	26.16561	11.91445	14
Education	2 High school	MEA	19.7672	18.59054	12.67768	22.70114	10.21353	14
Education	1 Less than high school	MEA	17.6846	16.2233	11.97884	19.98048	8.690577	14
Education	4 Masters and PhD	MEA	23.50866	21.00203	14.3142	28.68164	12.72757	14

Education	3 Bachelors	AFR	11.51853	10.42133	7.176567	11.47172	8.739651	17
Education	2 High school	AFR	9.453198	8.205438	4.934228	9.513345	8.128578	17
Education	1 Less than high school	AFR	14.74436	10.57031	6.439108	18.21417	12.14812	17
Education	4 Masters and PhD	AFR	14.10124	13.21581	8.950803	14.31825	9.370075	17
Relationship	all	EEU	19.65615	16.50204	14.74042	25.02101	7.352578	14
Relationship	married or living together	EEU	26.95004	25.53744	21.01644	29.60581	9.309353	14
Relationship	all	PAS	16.04781	18.33225	10.34725	21.95687	8.467937	7
Relationship	married or living together	PAS	26.98589	31.77214	14.54069	35.86341	16.00709	6
Relationship	all	MEA	20.07037	18.08933	17.30357	23.22641	7.275905	14
Relationship	married or living together	MEA	29.39996	27.99024	24.42681	30.06013	12.66248	14
Relationship	all	AFR	13.05026	9.704341	7.907681	14.02285	9.432412	17
Relationship	married or living together	AFR	21.56151	20.85003	13.42046	26.3053	12.56756	17
Family	all	EEU	19.72301	16.50204	14.74042	25.02127	7.346253	14
Family	parents of 9-18 yrs old	EEU	40.93445	36.72223	25.38711	54.08741	17.38716	14
Family	parents of 0-8 yrs old	EEU	48.32356	45.38572	26.4059	69.5658	21.68732	14
Family	all	PAS	17.76695	19.84571	15.73604	22.33525	7.858897	6
Family	parents of 9-18 yrs old	PAS	46.4557	51.65871	44.17689	54.97868	18.08481	6
Family	parents of 0-8 yrs old	PAS	47.37854	50.41734	44.79904	58.80463	18.39881	6
Family	all	MEA	20.25017	18.07863	17.21507	23.56921	9.000221	9
Family	parents of 9-18 yrs old	MEA	45.02887	42.27792	36.72485	47.78582	14.44847	9
Family	parents of 0-8 yrs old	MEA	52.20998	45.27609	40.16661	59.18929	17.93148	9
Family	all	AFR	17.7492	14.57473	10.70244	20.78841	11.84869	8
Family	parents of 9-18 yrs old	AFR	57.88733	64.68241	41.23898	73.24521	19.63665	8
Family	parents of 0-8 yrs old	AFR	58.91266	50	41.97587	78.44175	27.61471	7

Table S5: Correlation coefficients and Wilcoxon signed-rank test results for the comparison of social media and survey data in four countries (as in Figure 1)

	Pearson	Spearman	Kendall	Wilcoxon statistic	Wilcoxon p-value
US	0.076334	0.10303	0.022222222	25	0.845703125
India - MH and UP	0.091022	-0.02523	-0.025702886	121	0.173083961
India - states	-0.22139	-0.15325	-0.133333333	2	2.86102E-06
Mexico	0.559136	0.721265	0.570294336	33	1.4957E-06
Italy	0.157208	0.124812	0.073684211	0	1.90735E-06

Table S6: Wilcoxon signed-rank test results for the effect of demographic factors on AC interest (social media data) and AC purchases (surveys) in four countries (as in Figure 2)

Country	Data source	Attribute/Alternative hypothesis	Test statistic	p-value
US	Social media	Gender	55	0.000977
US	Survey	Gender	25	0.615234
US	Social media	Age18>35	0	1
US	Social media	Age35>65	0	1
US	Survey	Age18>35	34	0.27832
US	Survey	Age35>65	49	0.013672
US	Social media	Education edu2>edu1	41	0.09668
US	Social media	Education edu3>edu2	0	1
US	Survey	Education edu2>edu1	34	0.27832
US	Survey	Education edu3>edu2	30	0.422852
Italy	Social media	Gender	210	9.54E-07
Italy	Survey	Gender	165	0.011975
Italy	Social media	Age18>35	0	1
Italy	Social media	Age35>65	8	0.999982
Italy	Survey	Age18>35	167	0.009617
Italy	Survey	Age35>65	188	0.000508
Italy	Social media	Education edu2>edu1	64	0.938454

Italy	Social media	Education edu3>edu2	135	0.138678
Italy	Survey	Education edu2>edu1	169	0.007656
Italy	Survey	Education edu3>edu2	120	0.29791
India - states	Social media	Gender	169	1.14E-05
India - states	Survey	Gender	48	0.849473
India - states	Social media	Age18>35	2	0.999996
India - states	Social media	Age35>65	165	0.001671
India - states	Survey	Age18>35	33	0.681065
India - states	Survey	Age35>65	55	0.02523
India - states	Social media	Education edu2>edu1		
India - states	Social media	Education edu3>edu2	230	9.54E-07
India - states	Survey	Education edu2>edu1		
India - states	Survey	Education edu3>edu2	100	0.001432
India - MH and UP	Social media	Gender	90	0.422314
India - MH and UP	Survey	Gender	166	0.002135
India - MH and UP	Social media	Age18>35	6	0.995184
India - MH and UP	Social media	Age35>65	10	0.0625
India - MH and UP	Survey	Age18>35	121	0.017578
India - MH and UP	Survey	Age35>65	91	0.000737
India - MH and UP	Social media	Education edu2>edu1	33	0.106762
India - MH and UP	Social media	Education edu3>edu2	10	0.250092
India - MH and UP	Survey	Education edu2>edu1	33.5	0.962833
India - MH and UP	Survey	Education edu3>edu2	10	0.0328
Mexico	Social media	Gender	496	4.66E-10
Mexico	Survey	Gender	273	0.055468
Mexico	Social media	Age18>35	11	1
Mexico	Social media	Age35>65	496	6.44E-07
Mexico	Survey	Age18>35	270	0.063544
Mexico	Survey	Age35>65	333	0.00027
Mexico	Social media	Education edu2>edu1	295	0.048166
Mexico	Social media	Education edu3>edu2	410	1.68E-06
Mexico	Survey	Education edu2>edu1	375	4.49E-05
Mexico	Survey	Education edu3>edu2	372	5.5E-06