D. 4.2 WELLBASED Intermediate Analysis Report

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List of acronyms

- H2020 – Horizon 2020
- WP – Work Package
- Dx.x – Deliverable x.x
- NGO – Non-Governmental Organization
- SD – Standard Deviation3
- PSQI – Pittsburgh Sleep Quality Index
- MPI - Multidimensional Prognostic Index
- CGA – Comprehensive Geriatric Assessment
- IoT – Internet of Things
- LoRaWAN – Long Range Wide Area Network
- ISRCTN – International Standard Randomised Controlled Trail Number.
- EUR – Euro
- GB – Great Britain
- TK – Türkiye
- tVOC - Total Volatile Organic compounds
- HU – Hungary
- EPOV – European Energy Poverty Observatory
- CO_2 – Carbon dioxide

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Executive summary

The overarching objective of WELLBASED is to propose the design, implementation, and evaluation of a novel, comprehensive urban programme, based on the social ecological model, to significantly reduce energy poverty and its effects on the citizen's health and wellbeing. The programme is implemented and evaluated in Valencia-Spain, Heerlen-Netherlands, Leeds-United Kingdom, Edirne-Turkey, Obuda-Hungary, and Jelgava-Latvia. This Deliverable 4.2 (D4.2) presents the results of the intermediate data analyses regarding the evaluation of the impacts of WELLBASED on energy poverty, health and wellbeing in the six pilot sites at month 32 (30 October 2023) of the project. The intermediate results provide useful insights into the energy poverty, health and wellbeing status of the WELLBASED study participants. They also help to improve the ongoing evaluation and support the future implementation and exploitation of the WELLBASED results.

The preliminary analyses use the following data sources: self-reported questionnaires, health monitoring, IoT home devices and qualitative interviews. Data have been collected from September 2022 (M19) until September 2023 (M31). Descriptive data analyses are performed to define the preliminary study sample and the baseline study results.

In total, 1340 participants distributed over the six pilot sites have provided informed consent to participate in in the evaluation study, of which 651 in the intervention group and 689 in the control group. About two third of the participants is female, the average age of the participants is about 50 years and two third of the overall sample indicated having no paid work. A high level of the participants in the study experienced 3 or more chronic conditions, namely just above 40%. About 30% reported moderate to severe problems in discomfort and anxiety/depression, or on the mental health scales, reporting higher levels of depression, anxiety and stress. Following the health monitoring in the intervention group, about one fifth of participants was considered experiencing hypertension.

The data showed that most people use electricity as energy source (almost 95%). A low number of participants experienced their home as comfortable warm in winter (40%) or comfortable cold in summer (30%). Participants indicate taking several measures to deal with energy poverty including wearing extra clothes, turning off the heating or cooling, and heating or cooling only one room of the house to save money. Almost 20% indicated going to bed in the daytime to keep warm.

The indoor air quality data showed us different trends that could be attributed to seasonal variations between summer and winter. These trends include increasing indoor temperature mirroring that of outdoor temperatures.

The first interviews confirmed participants are struggling to deal with energy-poverty and that their health is impacted. Differences between pilots were observed.

In summary, this is the first intermediate analyses report presenting the results of the WELLBASED project in the six pilot sites of the project. The results of this intermediate analyses report provide insights into the recruitment numbers, the characteristics of the study sample participants, their energy poverty status, and their health and wellbeing.

1. Introduction to the deliverable

1.1 Deliverable objective and scope

The aim of this deliverable is to present the intermediate analysis regarding evaluation of WELLBASED in the six pilot sites at month 32 (October 2023) of the project, considering baseline data of the evaluation study.

1.2 Relation to other WPs and deliverables

This Deliverable will be complemented by D4.3 'Final pilot sites analysis report' in M45, as well as D4.4 'Data platform with data gathered' (M45), D4.5 'Report from the focus groups on evaluation' (M45) and D4.6 'Report on status of posting result' (M45).The WELLBASED project will end in M48 (March 2025).

In general, this deliverable is strongly linked to WP4's tasks related to data analysis. The results of the baseline data analysis presented in this deliverable form the starting point for further analysis and evaluation of the impacts of the WELLBASED urban programmes. It is also strongly related to WP3, responsible for implementation of the seven urban programmes and the evaluation study, and monitoring of recruitment and data collection. Equally, the research results will be exploited in WP5 and WP6, being publicly shared in a Policy Briefing and in a capacity building webinar. All WPs, tasks and deliverables this deliverable relates to are presented in Table 1.

Table 1. Deliverable 4.2 in relation to other WPs and deliverables

WP	Deliverable	Description
WP3	D3.1	Implementation plan for each pilot site (Leader: LNV)
	D3.2	Midterm recruitment report (Leader: EMC)
	Task 3.2	Pilots' implementation and monitoring in the six adapted urban programmes (Leader: TNO)
	D3.3	Intermediary report on the implementation of the urban programme (Leader: ASIDEES)
WP4	D4.1	Pilot sites evaluation framework (Leader: EMC)

	Task 4.2	WELLBASED platform creation and data gathering (Leader: INCLIVA)
	Task 4.3	Data analysis: evaluation of the effects on health & wellbeing (Leader: EMC)
	Task 4.4	Data analysis: cost-effectiveness assessment (Leader: EMC)
	Task 4.5	Qualitative data collection and realist evaluation (Leader: UNIVLEEDS)
WP5	Task 5.1	Analysis of existing and alternative ways of financing urban health interventions aimed to tackle energy poverty (Leader: MUTK)
	Task 5.2	Upscaling and replication (Leader: DEM)
	Task 5.3	Capacity-building webinars (Leader: ENC)
	Task 5.5	Policy Recommendations for the scaling up and transferability of evidence-based urban policies to reduce energy poverty (Leader: LNV)
WP6	Task 6.2	Communication activities (Leader: ENC)
	Task 6.3	Scientific and academic dissemination (Leader: EMC)
	Task 6.4	Exploitation, innovation and business models development (Leader: KVC)
WP7	Task 7.2	Ethics management (Leader: INCLIVA)
	Task 7.4	Data management (Leader: INCLIVA)

2. Methodology

2.1 Study sample

Details of the evaluation study set-up are presented in D4.1 'Pilot sites evaluation framework'. Information on the recruitment strategies and implementation is presented in D3.1 'Implementation plan for each pilot site' and D3.2 'Midterm recruitment report'.

In short, the WELLBASED study sample is based on convenience sample with a control and intervention group in each pilot study site. Participants could be included if they were considered vulnerable to energy poverty. Recruitment ended per July 1st, 2023, meaning consent had to be signed before that date. In some cases, in some sites, the consent was signed but the baseline questionnaire, health monitoring or installation of the home sensors was completed later in time.

The WELLBASED evaluation study runs parallel to the implementation of the WELLBASED interventions in the six pilot sites. A broad set of data is collected to be able to evaluate impact on several outcomes between and within study groups. Complementary methods are used. The data collection methods are presented in Table 2. The methods used are self-reported questionnaires for both study groups at baseline. Additional self-report, Internet of Things (IoT) sensors and qualitative interview data are obtained used to collect data among intervention participants. The next sections of this chapter describe the methodology of each of the data sources used for the analyses in this deliverable.

Table 2. Overview data collection sources for WELLBASED evaluation study

Data	Method	Study group	Frequency	Used in this deliverable?	Comments
Health, well-being, energy poverty and energy-efficiency	Self-reported questionnaires (individual and household)	Intervention + Control	Every six months	✓	Baseline self-reported questionnaires are included in this deliverable
Peak flow, oxygen saturation	Medical devices self-monitoring or	Intervention	Every month	✓	Baseline (first 3 months) health

(SpO_2), blood pressure and heart rate	nurse/physician monitoring				monitoring included in this deliverable
Pittsburgh Sleep Quality Index (PSQI)	Self-report questionnaire	Intervention	Every three months	✓	Baseline sleep quality is included in this deliverable
Indoor air quality (temperature, CO2 and humidity)	IoT home sensors	Intervention	Near real-time	✓	Data available differs per pilot site.
Several indicators related to outdoor environment and air quality	City-level data	Intervention + control	n/a	Partially	Outdoor temperatures are included in this deliverable, to contextualize the indoor temperature results for intervention participants.
Lived experience	Qualitative interviews	Intervention	One to three interviews	✓	Interview data available winter/summer period 2023 are included in this deliverable.

2.2 Self-report baseline questionnaires

An individual-level self-report questionnaire is used to collect data with regard to individual health and well-being and a household-level self-report questionnaire is used to collect data with regard to household characteristics. For details on the measurements used see D4.1 'Pilot sites evaluation framework', the trial registration (ISRCTN 14905838) as well as the design paper published by Stevens et al (2022) (1).

The individual questionnaire includes sociodemographic characteristics (e.g. education level), health and wellbeing outcomes (e.g. health-related quality of life, chronic conditions) and coping strategies (e.g. behaviour to deal with a cold home). All participants were invited to complete the individual questionnaire.

The household questionnaire was to be completed by one member of the household (if more than one household member participated) and included an assessment of energy usage (e.g. energy source and use), energy costs and household characteristics (e.g. owned or rented). Participants were free to decide by themselves which of the participating household members would complete the household questionnaire.

For this deliverable, the collected self-report individual and household questionnaire data available until 30 September 2023 were used. Descriptive data analyses were performed. More advanced statistical analyses will be done for Deliverable 4.4 and 4.5, as intervention implementation and follow-up data collection are currently ongoing in the pilot sites.

In this deliverable 4.2 the study sample is characterised in terms of sociodemographic characteristics (e.g. age, gender, education level, income, occupation, marital status, migration background, and living status). Moreover, the study sample is described in terms of indicators related to:

- Health and wellbeing
- Energy poverty status
- Energy efficiency, consumption and costs

The data were analysed within the WELLBASED repository using PSPP, version 2.0.0. Exchange rates for the Pound, Lira and Forint were calculated on June 6th, 2023, using Google currency convertor and set at 1 Pound GB = 1, 16 EUR, 1 Lira TK = 0,039 EUR, 1 Forint HU = 0, 0027 EUR.

2.3 Health monitoring

In the intervention condition, so called health monitoring was performed to collect additional data. This included monthly measures of Peak flow, oxygen saturation (SpO_2), blood pressure and heart rate.

Peak flow and SpO_2 are measured in a resting position and after a six minutes' walk. Blood pressure and heart rate are measured three times in a resting position with a three-minute interval. Health monitoring devices (e.g. peak flow device) are used to collect these data. Data was obtained manually by the participant him/herself or obtained by a nurse, research assistant or physician during scheduled visits. Data were reported in the WELLBASED platform.

In D4.2 the first three months of health monitoring data available for each participant in the intervention group is considered baseline (with final participants recruited in June 2023, data available up to September 30th 2023). This means that, for each participant, following the WELLBASED study design of monthly health monitoring, 0 up to 3 health monitoring assessments were potentially available.

For the analysis of blood pressure, only the second and third blood pressure measurement of each health monitoring are used to ensure accuracy following the recommendation of the European Society for Hypertension (2). The averages of all second and third blood pressure measurements are presented. Similarly, the averages of all blood pressure measurements for each participant are used to determine whether a participant suffers from hypertension (systolic BP > 140 mmHg or diastolic BP > 90 mmHg) or hypotension (2). Also, the average of all heart rate, SpO_2 and peak flow measurements is obtained. Averages are used to determine whether a participant suffers from tachycardia (heart rate > 90 bpm), bradycardia (heart rate < 50 bpm) and hypoxemia (SpO_2 < 92%).

Sleep quality is measured with the self-report questionnaire called the Pittsburgh Sleep Quality Index (PSQI), with a three-month interval. For sleep quality the baseline scores are included. The frequency distribution over the domains of the PSQI (3) are reported, as well as the total score of all seven domains. The total score is then divided into three categories indicating good sleep (total score 0-7), moderate disturbance (total score 8-14) and poor sleep (total score 15-21). (2)

The data were analysed within the WELLBASED repository using PSPP, version 2.0.0.

2.4 Indoor air quality

Among participants in the intervention condition, indoor air quality is measured using IoT home sensors that collect indoor temperature, humidity and CO_2 at household level. In each household one device is installed. Data is collected near real-time (minimal once per hour). Sensors are preferably positioned in the main corridor of the dwelling at a height of ~ 1, 5 meters. In case the corridor location is not possible or far away from the other rooms, the device is installed in the living room, away from windows and kitchen.

Data from pilot sites Valencia, Heerlen, Jelgava, Leeds and Edirne were available for analyses and included in D4.2. Data were available for differed time periods for each per pilot, depending on the purchase of the devices and installation.

Per air quality indicator (indoor temperature, humidity and CO_2) one graph is presented. This graph represents the average value of the indicator among all households participating in that pilot site. Per pilot graphs are presented in the appendices. Outdoor temperatures at city-level are included to contextualize the indoor temperature results in each pilot site. Minimum (18 degrees Celsius) and maximum (24 degrees Celsius) temperature, CO2 levels (maximum 1000 ppm), and humidity (30-70%) were set following the World Health Organisation's recommendations (4).

The sensors are connected to the Smart City (SMC) Platform, operated by ASIDEES, through LoRaWAN (Valencia, Leeds, Edirne), Sigfox (Jelgava) and Proprietary (Obuda, Heerlen) networks. The data are automatically transferred to the SMC platform, from where data are transferred to the WELLBASED repository.

Data collected period differed per pilot site, up to September 2023 were descriptively analysed using Microsoft Excel.

2.5 Qualitative interviews

The qualitative work aims to learn about people's experiences paying and using energy at home. The WELLBASED approach understands energy uses as those referring to heating and cooling, heating up water to wash, lighting and drying clothes and using electrical appliances. Similarly, we look into how those energy uses and access to energy affect other aspects of well-being, such as mental health-related issues and physical health. During the interview process, participants were asked about these experiences and how (and if) they managed to access adequate energy to meet their needs.

The methodology involved a round of interviews that were carried out during the Winter/summer period in 2023. The pilots targeted around 20 interviewees each; however, the context and availability of participants influenced the final number of interviews per case. The interviews were recorded and stored safely as soon as they were finished.

The interviews were semi-structured, allowing the interviewer some space to adapt questions to the particular interviewee. The interview protocol consisted of 7 main topics with some sub-questions. Some of the questions included were:

- T1.About the house/home/household and you
  - How did you come to live in this house? Can you explain how each person uses the house in a typical day?

- T2. About energy use in your home
  - How easy is it to keep your house at a good temperature? How affordable are your energy bills?
- T3. What do you do in your home to make it work?
  - How do you manage to keep the electricity bill affordable?
- T4. Wider effects
  - What are the effects of [cold/heat/damp/electrical access] on your social life?
- T5. Intervention

3. Findings

The sections below describe the number of recruited participants in each pilot site and response to the questionnaires, the baseline questionnaire results, and the health monitoring results, an overview of indoor air quality measurements and an overview of initial insights from qualitative interviews.

3.1 Study sample

The recruitment strategies of each pilot site have been described in D3.1 'Implementation plan for each pilot site' and in D3.2 'Midterm Recruitment Report'. A total number of 1340 participants have provided informed consent to participate in the WELLBASED study. Inclusion of participants ended July 1st, 2023. In total, 651 people are participating in the intervention group and 689 in the control group. Table 3 provides an overview of the distribution of recruited participants across pilot sites, including the total number.

Table 3. Final number of individual participants with informed consent in each pilot site per study group

	Valencia	Heerlen	Edirne	Jelgava	Leeds	Obuda	Total
Intervention group	145	132	124	124	30	96	651
Control group	177	101	125	33	219	34	689
Total	322	233	249	157	249	130	**1340**

3.2 Self-report baseline questionnaires

This section describes the response on and the outcomes from the self-reported baseline questionnaires. The first part shows the socio-demographic characteristics of the sample and the second part provides insight into several indicators related to health, wellbeing, and energy poverty and coping strategies.

A total of 1181 individual and 1093 household baseline questionnaires were available for analyses up to September 30th, 2023.

Table 4. Individual questionnaires completed by each pilot site per study group

	Valencia	Heerlen	Edirne	Jelgava	Leeds	Obuda	Total
Intervention group[a]	145/145 (100%)	85/132 (64.4%)	122/124 (98.4%)	123/124 (99.2%)	8/30 (26.7%)	82/96 (85.4%)	565/651 (86.8%)
Control group[b]	177/177 (100%)	75/101 (74.3%)	119/125 (95.2%)	33/33 (100%)	183/219 (83.6%)	29/34 (85.0%)	616/689 (89.4%)
Total[c]	322/322 (100%)	160/233 (68.7%)	241/249 (96.8%)	156/157 (99.4%)	191/249 (76.7%)	111/130 (85.4%)	1181/1340 (88.1%)

[a] Total number of participants with a returned individual questionnaire in the intervention group/ total number of participants with informed consent in the intervention group (response percentage)

[b] Total number of participants with a returned individual questionnaire in the control group/ total number of participants with informed consent in the control group (response percentage)

[c] Total number of participants with a returned individual questionnaire/ total number of participants with informed consent (response percentage)

Table 5. Household questionnaires completed by each pilot site per study group

	Valencia	Heerlen	Edirne	Jelgava	Leeds	Obuda	Total
Intervention group	142	55	122	123	8	62	512
Control group	177	55	119	33	173	24	581
Total	319	110	241	156	181	86	1093

3.2.1 Sociodemographic characteristics

Table 6 describes the characteristics of participants included in the overall study. In Annexes 1 to 6 the socio-demographic characteristics per pilot site are presented. The average age was 49.4 years with a standard deviation of 16.0 years and 65.1% identified as female. Additionally, 42.5% was married or partnered, 45.4% completed higher education, and 21.6% has a migration background; 43.7% of participants are home owners.

Table 6. Characteristics of participants (n=1181)

	Intervention group	Control group	Total
Gender, n (%)			
Female	366 (64.8%)	403 (65.4%)	769 (65.1%)
Male	198 (35.0%)	211 (34.3%)	409 (34.6%)
Prefer not to say	0	1 (0.2%)	1 (0.1%)
Other	1 (0,2%)	1 (0.2%)	2 (0.2%)
Age (years)			
Mean (SD)	51.2 (17.0)	47.8 (14.9)[a]	49.4 (16.0)[a]
Older people (>65 years)	125 (22.1%)	77 (12.5%)	202 (17.1%)
Marital status, n (%)			
Married	257 (45.5%)	245 (39.8%)	502 (42.5%)
Single, separated, divorced or widowed	308 (54.5%)	371 (60.2%)	679 (57.5%)
Educational level, n (%)			
Post-secondary or lower	268 (47.4%)	377 (61.2%)	645 (54.6%)
Higher education	297 (52.6%)	237 (38.5%)	534 (45.2%)
Missing	0	2 (0.3 %)	2 (0.2%)
Household income category, n (%)			
1 (Less than 750€)	228 (40.4%)	285 (46.3%)	513 (43.4%)
2 (751 € to under 1.000 €)	48 (8.5%)	104 (16.9%)	152 (12.9%)
3 (1.001 € to under 1.300 €)	82 (14.5%)	78 (12.7%)	160 (13.5%)
4 (1.301 € to under 1.650 €)	54 (9.6%)	52 (8.4%)	106 (9.0%)
5 (1.651 € to under 2.000 €)	28 (5.0%)	24 (3.9%)	52 (4.4%)
6 (2.001 € to under 2.350 €)	30 (5.3%)	18 (2.9%)	48 (4.1%)
7 (2.351 € to under 2.800 €)	36 (6.4%)	14 (2.3%)	50 (4.2%)

	8 (2.801 € to under 3.500€)	29 (5.1%)	9 (1.5%)	38 (3.2%)
	9 (3.500 € or more)	29 (5.1%)	31 (5.0%)	60 (5.1%)
	Missing	1 (0.2%)	1 (0.2%)	2 (0.2%)
Paid work, n(%)				
	Yes, by respondent	210 (37.2%) [b]	178 (28.9%) [c]	388 (32.9%) [d]
	Yes, by respondent's partner	134 (23.7%) [e]	88 (14.3%) [f]	222 (18.8%) [g]
	No	348 (61.6%)	406 (65.9%)	754 (63.8%)
Household composition, n (%)				
	Single-adult with children	27 (5.3%)	51 (8.8%)	78 (7.1%)
	Single-adult without children	116 (22.7%)	129 (22.2%)	245 (22.4%)
	Two or more adults with children	166 (32.4%)	172 (29.6%)	338 (30.9%)
	Two or more adults without children	195 (38.1%)	201 (34.6%)	396 (36.2%)
	Missing	8 (1.6%)	28 (4.8%)	39 (3.3%)
Migration background, n (%)				
	Yes	109 (19.3%)	146 (23.7%)	255 (21.6%)
	No	455 (80.5%)	469 (76.1%)	924 (78.2%)
	Missing	1 (0.2%)	1 (0.2%)	2 (0.2%)
Belonging to an ethnic minority, n (%)				
	Yes	22 (3.9%)	28 (4.4%)	50 (4.2%)
	No	457 (80.9%)	535 (86.9%)	992 (84.0%)
	Prefer not to say/don't know	86 (15.2%)	52 (8.5%)	138 (11.7%)
	Missing	0	1 (0.2%)	1 (0.1%)
Dwelling type , n (%)				
	Detached	171 (33.4%)	134 (23.1%)	305 (27.9%)
	Semi-detached/terraced	43 (8.4%)	124 (21.3%)	167 (15.3%)
	Apartment or flat	280 (54.7%)	280 (48.2%)	560 (51.2%)
	Other	11 (2.1%)	16 (2.8%)	27 (2.5%)
	Missing	7 (1.4%)	27 (4.6%)	34 (3.1%)
Tenure status, n (%)				
	Owner	279 (54.5%)	199 (34.3%)	478 (43.7%)
	Rented at market rate	114 (22.3%)	162 (27.9%)	276 (25.3%)
	Reduced rent/social housing/free rent	103 (20.1%)	167 (28.7%)	270 (24.7%)
	Other	10 (2.0%)	26 (4.5%)	36 (3.3%)
	Missing	6 (1.2%)	27 (4.6%)	33 (3.0%)

[a] 4 missing, [b] 7 missing, [c] 32 missing, [d] 39 missing , [e] 266 missing, [f] 321 missing, [g] 587 missing

3.2.2 Health and wellbeing outcomes

The EQ-5D-5L instrument assesses five dimensions of health-related quality of life: mobility, self-care, pain/discomfort, daily activities and anxiety/depression. In each of the five dimensions there are five levels of perceived problems. Table 7 shows the frequencies for each level of perceived problem per dimension. The health thermometer which asks participants to rate their health on a scale from 0 to 100 yielded an average score of 68.5 (SD 20.0) (5 missings). Table 8 shows the number of chronic diseases reported: 37.5% reported to be diagnosed with 1 to 2 chronic diseases, whereas 41.3% reported to suffer from 3 or more chronic diseases such as asthma, cardiovascular disease and cancer.

Table 7. Health-related quality of life dimensions (n=1181)

EQ-5D-5L[a]	Level 1 – no problem	Level 2 – slight problems	Level 3 – moderate problems	Level 4 – severe problems	Level 5 – unable to/extreme problems
Mobility	721 (61.0%)	234 (19.8%)	134 (11.3%)	83 (7.0%)	7 (0.6%)
Self-care	959 (81.2%)	137 (11.6%)	62 (5.2%)	15 (1.3%)	6 (0.5%)
Usual activities	760 (64.4%)	219 (18.5%)	138 (11.7%)	46 (3.9%)	16 (1.4%)
Pain/Discomfort	414 (35.1%)	373 (31.6%)	223 (18.9%)	131 (11.1%)	38 (3.2%)
Anxiety/Depression	552 (46.7%)	332 (28.1%)	177 (15.0%)	81 (6.9%)	37 (3.1%)
[a] 2 missing					

Table 8. Chronic disease (n=1181)

Chronic conditions		n (%)
No. of chronic conditions [a]		
	0	250 (21.2%)
	1-2	443 (37.5%)
	3 or more	487 (41.2%)
[a] 1 missing		

The Depression, Anxiety and Stress scale (DASS-21) (Table 9) assessed symptoms of depression, anxiety and stress. The results are categorized into five categories ranging from normal to extremely severe symptoms. A total of 15.3% suffers from (extremely) severe depression symptoms, 21.5% from (extremely) severe anxiety symptoms and 13.1% from (extremely) severe stress symptoms.

Table 9. Participant's mental health and well-being (n=1181)

DASS-21		**n (%)**
Depression		
	Normal	687 (58.2%)
	Mild	144 (12.2%)
	Moderate	169 (14.3%)
	Severe	82 (6.9%)
	Extremely severe	99 (8.4%)
Anxiety		
	Normal	649 (55.0%)
	Mild	76 (6.4%)
	Moderate	202 (17.1%)
	Severe	100 (8.5%)
	Extremely severe	154 (13.0%)
Stress		
	Normal	769 (65.1%)
	Mild	129 (10.9%)
	Moderate	128 (10.8%)
	Severe	110 (9.3%)
	Extremely severe	45 (3.8%)

Table 10 presents the results from the evaluation of multidimensional frailty among participants aged 65 and older (n=210). Frailty, conceptualized as a multidimensional construct, is evaluated using the Comprehensive Geriatric Assessment (CGA) which is the gold standard for the assessment of elderly people (aged≥65 years) and takes into account all the following domains: health status, functional status, mobility, cognition, nutrition, physical activity and psychosocial context. In this perspective, the SELFY-BRIEF-MPI is a self-administered and short version of the standard Multidimensional Prognostic Index (MPI) (5, 6, and 7). The SELFY-BRIEF-MPI includes 8 domains: basal and instrumental activities of daily living (ADL, IADL), mobility (MOB), cognitive status (COG), nutrition status (MNA), co-morbidities (COM), number of

medications taken (DRUG), and co-habitation status (CO-HAB). Subjects who are in the categories low, moderate and high, respectively have a mild, moderate, and severe risk of developing negative clinical outcomes, such as hospitalization, institutionalization and mortality, as reported in literature.

The findings show that older people in the WELLBASED study (mean age= 73.5, SD=6.2, female= 70%) is at major frail risk conditions in the following domains: comorbidities (46.4% of participants is at moderate risk of frailty and 41.2% at high risk condition) and co-habitation status (51.7% of participants is at high risk condition). Moreover, the 29.5% of the total sample is in a moderate frailty risk condition with a moderate risk of developing negative clinical outcomes, such as hospitalization, institutionalization and mortality, and the 4.8% of the older sample is at high risk of frail with the related high risk of negative clinical outcomes. Annex 1 to 6 provide the results per pilot site.

Table 10. Frailty in older participants (n=210 who completed the SELFY-BRIEF-MPI)

SELFY-BRIEF-MPI		n (%)
ADL[1]		
	Low[2]	157 (75.1%)
	Moderate[3]	39 (18.7%)
	High[4]	13 (6.2%)
IADL[5]		
	Low	160 (76.6%)
	Moderate	17 (8.1%)
	High	32 (15.3%)
Mobility		
	Low	156 (74.6%)
	Moderate	29 (13.9%)
	High	24 (11.5%)
Cognitive status		
	Low	110 (52.6%)
	Moderate	44 (21.1%)
	High	55 (26.3%)
Nutritional status		
	Low	191 (91.4%)
	Moderate	15 (7.2%)
	High	3 (1.4%)
Comorbidity		

	Low	26 (12.4%)
	Moderate	97 (46.4%)
	High	86 (41.2%)
No. of drugs		
	Low	117 (56.0%)
	Moderate	57 (27.3%)
	High	25 (12.0%)
Co-habitation status		
	Low	95 (45.5%)
	Moderate	3 (1.4%)
	High	108 (51.7%)
Final score		
	Low	138 (65.7%)
	Moderate	62 (29.5%)
	High	10 (4.8%)

[1] ADL (Activities of Daily Living);

[2] IADL (Instrumental Activities of Daily Living);

[3] Low represents people who are at low risk of the related domain;

[4] Moderate represents people who is at a moderate risk of the related domain;

[5] High represents people who is at high risk of the related domain

Table 11. Participant's lifestyle (n=1181)

Variable		**n (%)**
Smoker		
	yes	327 (27.7%)
	no	601 (50.8%)
	ex-smoker	253 (21.4%)
Average time spent inside the house during daytime [b]		
	0-3 hours	70 (5.9%)
	3-6 hours	400 3.9%)
	6-9 hours	362 (30.7%)
	> 9 hours	347 (29.4%)

[a] 35 missing; [b] 2 missing

Table 11 provides outcomes related to participant's lifestyle. Smoking is done by 27.7%, and 29.4% spends more than 9 hours inside the house during daytime.

The self-reported questionnaire also contained questions about health care use. Table 12 discloses the information obtained with regard to care use among the sample population. It can be seen that 73.7% visited a doctor in the last 12 months, and 28.6% visited the hospital accident & emergency room. Among the study sample, 12.8% stayed overnight in the hospital for at least one night, and 6.3% spent 3 or more nights in the hospital.

Table 12. Participant's health care use (n=1181)

SMRC Health Care Utilization		**n (%)**
No. of physician visits in the past 12 months [a]		
	0	310 (26.2%)
	1-2	404 (34.2%)
	3 or more	466 (39.5%)
No. of hospital accident & emergency visits in the past 12 months[a]		
	0	842 (71.3%)
	1-2	254 (21.5%)
	3 or more	84 (7.1%)
No. of different times staying in the hospital overnight or longer in the past 12 months[a]		
	0	1029 (87.1%)
	1-2	118 (10.0%)
	3 or more	33 (2.8%)
No. of total nights spent in hospital in the past 12 months [b]		
	0	1030 (87.2%)
	1-2	75 (6.4%)
	3-7	52 (4.4%)
	8 or more	22 (1.9%)
[a] 1 missing, [b] 2 missing		

3.2.3 Energy-related measurements

In Table 13 the energy consumption is presented. Participants could indicate all energy sources they use. Most households used electricity (94.2%). Those who used electricity had an average monthly consumption of 353.90 kWh (SD 861.1) and the average costs were reported as €123.18 (SD 959.18). There were many missing data for these questions and the reported numbers had a large SD.

Table 13. Energy consumption and costs (n=1181)

Variable		
Household energy source		
	Electricity, n (%)*	1030 (94.2%)
	Gas, n (%)**	392 (35.9%)
	Derived heat/ district heating, n (%)***	137 (12.5%)
	Other (e.g. oil/petroleum products, renewables or coal products), n (%)****	331 (30.3%)
Monthly energy consumption		
	Electricity (kWh), mean (SD)[1]	353.9 (861.1)
	Gas (m^3), mean (SD)[2]	267.5 (1397.8)
	Derived heat (kWj), mean (SD) [3]	54.3 (51.4)
Monthly energy costs,		
	Electricity (€), mean (SD)[a]	123.18 (959.18)
	Gas (€), mean (SD)[b]	209.40 (571.15)
	Derived heat (€), mean (SD)	97.22 (109.99)
	Other sources (€), mean (SD)[c]	19.32 (28.64)
Received support towards energy bills		
	Yes, fixed amount of money, n (%)	168 (15.4%)
	Yes, percentage of costs refunded, n (%)	77 (7.0%)
	Yes, in kind contribution, n (%)	146 (13.4%)
	Yes, other type of support, n (%)	84 (7.7%)

* 62 (5.7%) missing

** 64 (5.9%) missing

*** 62 (5.7%) missing

**** 45 (4.1%) missing

[1] Data were missing for 53.6% of respondents using electricity (553 missing)

[2] In case of missing billing period, the period reported for electric was used if available. Data were missing for 51.8% of respondents using gas (203 missing).

[3] Data were missing for 89.1% of respondents using derived heat (122 missing)

[a] Data were missing for 0.5% of respondents using electricity. Extreme outliers were not considered, corresponding Z-scores of 2.0 and higher were counted as missing sins electricity bills of €13.000,- were considered unlikely.

[b] Data were missing for 1.5% of respondents using gas. Monthly gas bills of €10,000 or higher were considered unlikely and there for left out.

[c] Data were missing for 9.4% of respondents using other sources

Table 14 shows the number of participants that are reported to experience energy poverty according to the EPOV indicators (8). In total 58.4% of the participants indicated that the dwelling was not comfortable warm in winter time and 69.7% reported the dwelling not to be comfortably cool in summer time. In 43.3% of the households leak/damp/rot was reported to be present. Of all participants 38.8% indicates not being satisfied with the status of their home.

Table 14. Participant's energy poverty status (n=1181)

EPOV indicators[a]		**n (%)**
Dwelling comfortably warm in winter time		
	Yes	491 (41.6%)
	No	690 (58.4%)
Dwelling comfortably cool in summer time		
	Yes	357 (30.3%)
	No	824 (69.7%)
Arrears on utility bills [b]		
	Yes, once	116 (10.6%)
	Yes, twice or more	371 (33.9%)
	No	573 (52.4%)
Presence of leak/damp/rot [c]		
	Yes	473 (43.3%%)
	No	512 (46.8%)
	I don't know	75 (6.9%)
Equipped with heating facilities [d]		
	Yes, central heating or similar	506 (46.3%)
	Yes, other fixed heating	301 (27.5%)
	Yes, non-fixed	197 (18.0%)
	No	56 (5.1%)

Equipped with air conditioning (cooling) facilities [e]		
	Yes	174 (15.9%)
	No	880 (80.5%)
	I don't know	5 (0.5%)
Equipped with adequate electrical installations [f]		
	Yes	711 (65.1%)
	No	290 (26.5%)
	I don't know	59 (5.4%)
Home satisfaction[g]		
	(very) dissatisfied	458 (38.8%)
	(very) satisfied	710 (60.1%)

[a] Categorisation according to EPOV methodology (8)

[b] 33 (3.0%) missing

[c] 33 (3.0%) missing

[d] 33 (3.0%) missing

[e] 34 (3.1%) missing

[f] 33 (3.0%) missing

[g] 13 (1.1%) missing

In table 15 the coping strategies to deal with energy-related issues that participants reported are presented. In Annex 1 to 6 the results of the coping strategies 'turning of heating/cooling' and 'heating/cooling only one room' are presented per pilot. Over half (53.9%) of participants report often or always wearing extra clothes to stay warm. Also, almost half (45.9%) indicated to often or always turn off heating/cooling to save money.

Table 15. Energy-related coping strategies in the past 12 months (n=1181)

Variable		**n (%)**
Wearing extra clothes to keep warm		
	Never or rarely	258 (21.8%)
	Sometimes	286 (24.2%)
	Often or always	637 (53.9%)
Turning heating/cooling off to save money [a]		
	Never or rarely	280 (23.7%)
	Sometimes	142 (12.0%)
	Often or always	542 (45.9%)

	Not an option in my dwelling	216 (18.3%)
Heating/cooling only one room of the house to save money		
	Never or rarely	329 (27.9%)
	Sometimes	99 (8.4%)
	Often or always	551 (46.7%)
	Not an option in my dwelling	202 (17.1%)
Going to bed in the daytime to keep warm [b]		
	Never or rarely	693 (58.7%)
	Sometimes	227 (19.2%)
	Often or always	258 (21.8%)
Going to a public building to keep warm/ cool [c]		
	Never or rarely	998 (84.5%)
	Sometimes	139 (11.8%)
	Often or always	42 (3.6%)
Going to a neighbour or friends/relatives house to keep warm/cool [d]		
	Never or rarely	977 (82.7%)
	Sometimes	156 (13.2%)
	Often or always	47 (4.0%)
Bathing/showering less to save money		
	Never or rarely	837 (70.9%)
	Sometimes	190 (16.1%)
	Often or always	154 (13.0%)
Turning off lights in rooms that are being used to save money [e]		
	Never or rarely	343 (29.0%)
	Sometimes	213 (18.0%)
	Often or always	623 (52.8%)
Not cooking/eating cold food to save money [f]		
	Never or rarely	953 (80.7%)
	Sometimes	134 (11.3%)
	Often or always	93 (7.9%)
Avoided going to the doctor to save money		
	Never or rarely	854 (72.3%)
	Sometimes	55 (4.7%)
	Often or always	37 (3.1%)
	Health care is for free in my country	235 (19.9%)
[a] 1 missing, [b] 3 missing, [c] 2 missing, [d] 1 missing, [e] 2 missing, [f] 1 missing		

3.3 Health monitoring

In this section the results from the health monitoring performed in the intervention group are presented.

Table 16 presents the participants in the intervention group and the numbers of health monitoring performed (study protocol: monthly). Of the n=648 intervention group participants, in total 557 participants in the intervention group that received health monitoring (85.6%). In almost all pilots among participants with health monitoring data available, an average number of 3 times health monitoring was observed.

Table 16. Health monitoring of intervention group participants in each pilot site (n=648)

	Valencia	Heerlen	Edirne	Jelgava	Leeds	Obuda	Total
Intervention group participants, n	145	132	124	124	30	96	651
Participants with at ≥1 health monitoring, n/ntotal (%)	145/ 145 (100%)	89/132 (67.4%)	124/124 (100%)	115/124 (92.7%)	17/30 (56.7%)	67/96 (69.8%)	557/651 (85.6%)
Age, years (SD)[a]	53.79 (15.07)	51.52 (17.23)	43.05 (12.40)	49.26 (18.40)	44.50 (15.80)	45.68 (15.72)	48.61 (17.13)
Total number of health monitoring performed, n[b]	433	282	608	386	56	202	1967
Sex , female, n/ntotal (%)[c]	43/101 (70.1%)	21/36 (63.1%)	64/58 (47,5%)	31/84 (73.0%)	4/5 (55.5%)	22/40 (64.5%)	185/325 (56.9%)
Number of health monitoring performed, n/ntotal (%)	433/145 = 2.98	282/89= 3.2	608/124= 4.9	386/115= 3.4	56/17= 3.3	202/67= 3.0	1967/660= 2.98

Total health monitoring performed (%)[d]	22.01 %	14.34%	30.91%	19.62%	2.85 %	10.27 %	100 %

[a] Average age of participants with health monitoring data available.

[b] Total number of health monitoring moments available.

[c] Number of females within the total number of health monitoring moments available

[d] Overall percentage of health monitoring moments attributable to each pilot site (total number of monitoring moments performed, n=1967, is 100%).

In table 17 the number of participants with hypertension is shown to be around a fifth (i.e. 22.6% at the first monthly assessment). At each health monitoring around 10% experienced high heart rate (Tachycardia). Very few cases were observed with Hypoxemia, <2.0% across health monitoring. Peak flow was observed to be in the green zone on average for 34.8%, 35.6% and 37.1% of the participants at the first, second and third health monitoring respectively.

Table 17. Blood pressure, heart rate, oxygen saturation and peak flow (n=469)

		1st health monitoring (n=557)	2nd health monitoring (n=477)	3rd health monitoring (n=477)
Blood pressure[a]				
	Average systolic blood pressure (mmHg), mean (SD)[a]	128,4 (19.4)	124,9 (18.9)	123,1 (18.2)
	Average diastolic blood pressure (mmHg), mean (SD)[a]	81.1 (11.4)	80,5 (11.1)	79.6 (10.9)
	Systolic blood pressure (mmHg), P25 - P75	115-138	113-135	111-132
	Diastolic blood pressure (mmHg), P25 - P75	74-88	73-87	72-86
	Hypertension (≥140 and or ≥90 mmHg)[a]			
	Yes, n/ntotal (%)	154 / 566 (27.2 %)	107 / 477 (22.4%)	84 / 477 (17.6%)
	Hypotension (≤90 and or ≤40 mmHg)[a]			

Yes, n/ntotal (%)	5 / 566 (0.8 %)	5 / 477 (1.0%)	6 / 477 (1.2 %)
Heart rate			
Heart rate (bpm), mean (SD)	78.0 (12.5)	77.5 (12.4)	77.4 (12.3)
Heart rate (bpm), P25 - P75	69 -86	68 -86	69 -86
Tachycardia (> 90 bpm)	66 / 566 (11.6 %)	49 / 477 (10.2 %)	42 / 477 (8.8 %)
Bradycardia (< 50 bpm)	3 / 566 (0.5 %)	3 / 477 (0.6 %)	3 / 477 (0.6 %)
Oxygen saturation (SpO_2)			
SpO2, mean percentage (SD)	97.0 (2.65)	97.1 (1.67)	97.2 (1.91)
SpO2 (percentage), P25 - P75	96-99	97-99	97-99
Hypoxemia (SpO_2 < 92%)	9 / 566 (1.5 %)	4 / 477 (0.8 %)	7 / 477 (1.4 %)
Peak flow			
Global L/m, mean (SD)	347.24 (168.6)	354.51 (173.9)	358.0 (173.7)
Peak flow (L/m), P25 - P75	210-449	210-450	220-450
% in 'green' >400 L/m	152 / 566 (34.8 %)	170/ 477 (35.6 %)	177 / 477 (37.1 %)
% in yellow 399-250 L/min	189 / 566 (33.39 %)	178 / 477 (32.79 %)	172 / 477 (36.05 %)
% in red <250 L/min	131 / 566 (23.14 %)	120 / 477 (25.15 %)	99 / 477 (20.75 %)

[a] Second and third measure (of three measures of blood pressure in total in each health monitoring) were used for analyses, according to the guidelines of the ESH (2).

3.3.1 Pittsburgh sleep quality

There were n=541 out of 651 participants who completed the sleep quality questionnaire at baseline (table 18). In Annex 8 the results over each pilot site are presented. Figure 1 shows the percentage of participants choosing to experience for this specific domain 0= no difficulty, 1= little difficulty, 2= moderate difficulty or 3=severe difficulty. As can be seen, there were few participants experiencing difficulties and needing sleeping medication. A relatively large percentage experienced moderate difficulties with sleep disturbances. Participants reported overall good sleep (50%), 45% reported moderate disturbances and only 5% reported poor sleep (Table 19).

Table 18. Sleep quality among intervention group participants in each pilot site (n=651)

	Valencia	Heerlen	Edirne	Jelgava	Leeds	Obuda	Total
Sleep quality questionnaires completed, n/n intervention group	144/145	62/132	46/124	122/124	17/30	62/96	541/651

Figure 1. Scoring across sleep quality domains

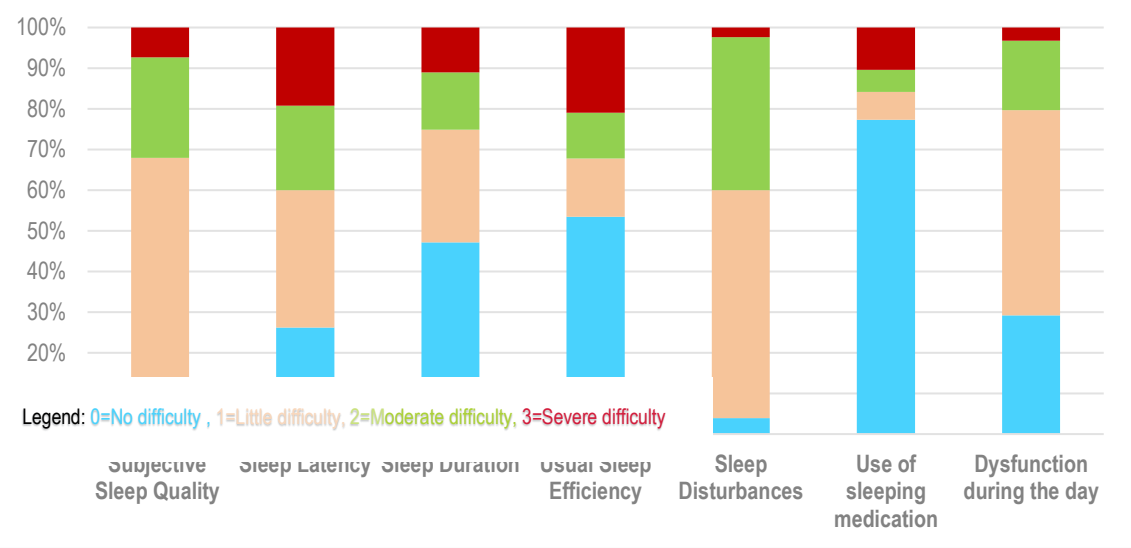


Table 19. Participant's sleep quality

Pittsburgh sleep quality index (PSQI)	
Total score (range 0-21), n	446
Good sleep (score 0-7), n(%)	219 (50%)
Moderate disturbance (score 8-14), n (%)	197 (45%)
Poor sleep (score 15-21), n(%)	30 (5%)

3.4 Indoor air quality

In table 20 the numbers of installed devices among intervention households are presented. Figure 2 to Figure 6 present a graphical representation of the average temperatures, CO2 levels and humidity across the participating households in all pilot sites.

Table 20. Intervention group participants with IoT home devices installed in each pilot site

	Valencia	Heerlen	Edirne	Jelgava	Leeds	Obuda	Total
IoT devices installed	125	132	38	114	21	34	464

Figure 2 shows that on average the highest average household temperatures were measured in Valencia and lowest average household temperatures were measured in Leeds. The data collection presented in Figure 2 starts in January 2023 (winter) and ends in July 2023 (summer); the increased average outdoor temperature over time due to the season is also reflected in the average indoor household temperatures across all pilot sites. This is also visible in Figure 3, when during the summer period the percentage of time that on average the household temperature was above the recommended maximum of 24 degrees Celsius was higher and highest in the warmest pilot sites. In Figure 4 the opposite occurs for the winter period, with the coldest pilot sites having on average highest percentage of times households below the recommended temperature of 18 degrees Celsius. Figure 5 shows the average CO_2- levels across households in Valencia, Jelgava and Heerlen. In all three pilots sites the average CO2 levels in the winter period are higher than in the summer period and across the three pilot sites a decrease can be seen. Figure 6 shows the average daily humidity in households in Valencia, Jelgava, Heerlen, Leeds and Edirne. It can be seen that on average Leeds and Valencia have higher humidity levels than Heerlen, Jelgava and Edirne.

Figure 2. Average daily temperature across all participating households in each pilot site, including thresholds (min. 18 and max. 24 degrees Celsius)

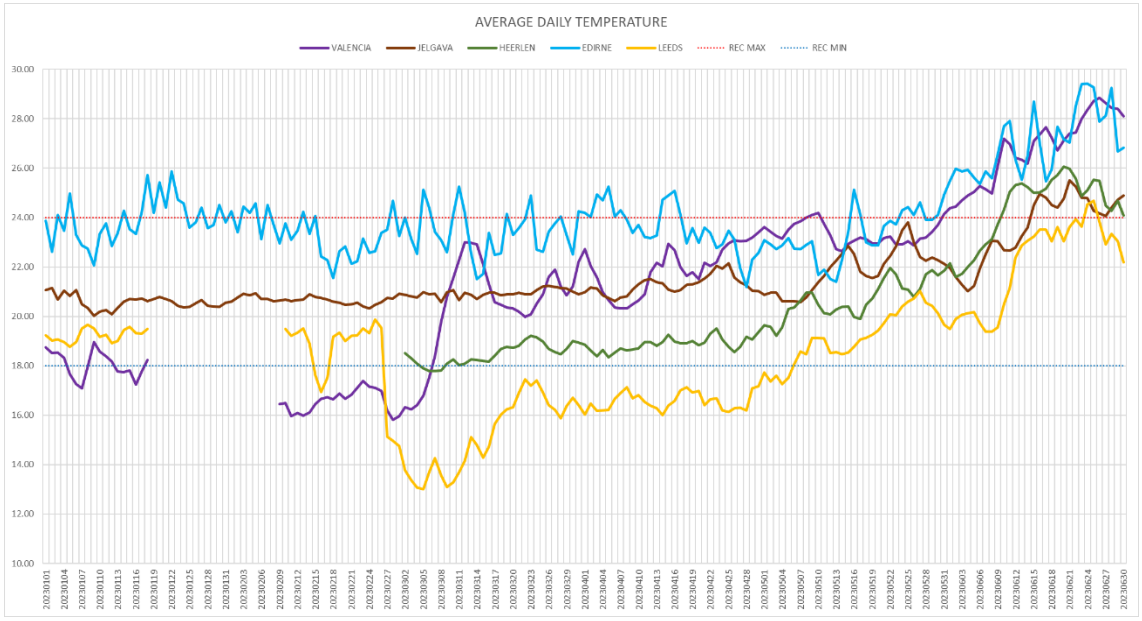


Figure 3. Percentage of time above the recommended maximum temperature (24 degrees Celsius) across households participating in each pilot site

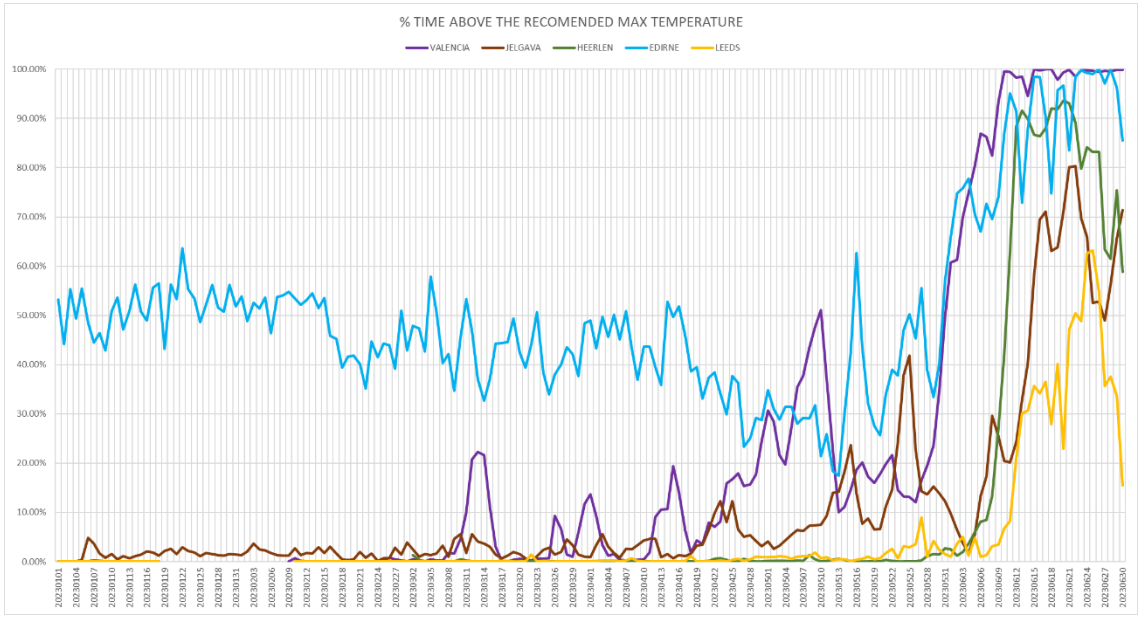


Figure 4. Percentage of time below the recommended minimum temperature (18 degrees Celsius) across households participating in each pilot site

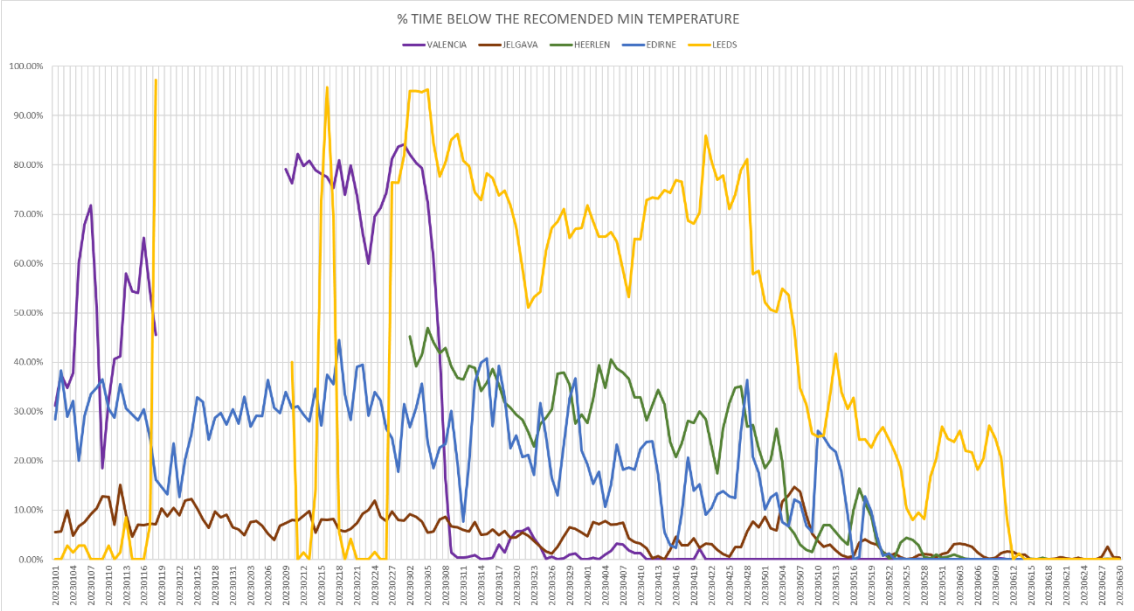


Figure 5. Average daily CO2 levels across households in each pilot site including CO2 thresholds (max. 1000 ppm)

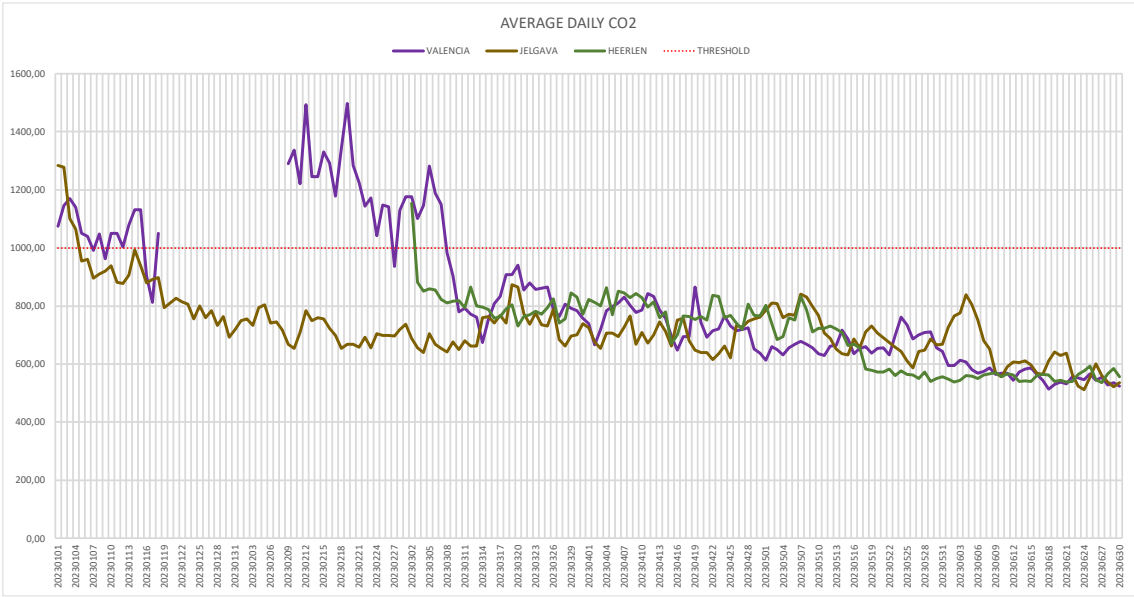
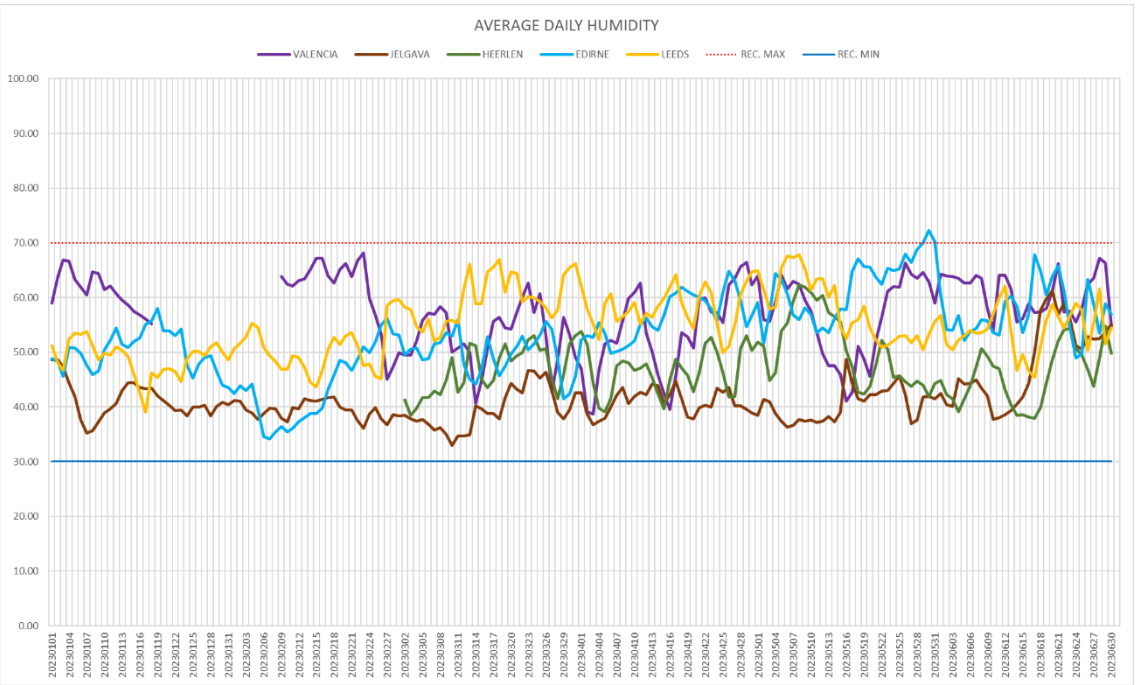


Figure 6. Average daily humidity levels across households in each pilot site including humidity thresholds (min 30%, max 70%)



3.5 Qualitative interviews

At the time of writing, the situation differs per case being at various stages of the qualitative research. In table 21 an overview is provided of the number of interviews performed per pilot site and the sample composition. The first round of interviews were finished for two pilots, Leeds and Valencia, and the analysis phase has started. For Jelgava and Obuda, the interviews were also completed on time. However, the analysis process has not already started. Finally, the first interview round has not yet been conducted for the Heerlen and Edirne pilots. Therefore, the quality/ quantity of data presented in the section might vary. Below, we show the main results for the Leeds and Valencia pilots. We can also anticipate some expected results for the rest of the pilots.

Table 21. Overview of characteristics of interview participants.

Pilot	N. of interviews	Sample composition
Edirne	N/A	N/A
Heerlen	N/A	N/A
Jelgava	22	Most interviewees were women, with a group of elderly, single mothers and students.
Leeds	11	The sample includes five males and six females with different backgrounds and origins (British nationals, immigrants). There is a mix of families, with and without children, single parents and one-person households
Obuda	22	Around 80% were women comprising older women and single mothers.
Valencia	12	The sample includes more women and diverse household structures, diversified in age, ethnicity, and family composition.

The main results in Leeds demonstrate that people struggle to keep their households warm and comfortable. Some houses also deal with dampness and mould. The general condition of the house affects the perception of their home as a space for living and interacting. The cost of living crisis has also aggravated this. In the interviews, the Leeds pilot also identified how mental and physical health is affected by this situation. Physically, the house's infrastructure adversely affects people's health; some interviewees could see how respiratory conditions like asthma, recurrent colds and skin rashes resulted from a poor living environment. The number of social interactions and activities has diminished, too. This has affected mental health, as people now struggle to pay bills and keep their families warm and healthy. This has very negative consequences, with increased levels of anxiety and stress. At this point, some interviewees also mentioned how they now need to prioritise needs.

An economically challenging situation in Valencia affected houses differently; in some cases, scarce economic resources forced divorcees to live together, and some people were on social benefits. The houses were mostly located by the sea and were perceived as humid and poorly insulated. Most of them do not have central heating or AC system, and temperatures within the houses are pretty extreme: in summer (+30ºC) and winter (below 18ºC). Despite this, some of the tenants are afraid of asking landlords for some

work in the house that could improve their situation. The interviewees identified the effects of this on their physical health: pain in extremities due to humidity, recurring colds and respiratory issues. During the heating season, they could feel low blood pressure and fatigue, headaches and tiredness and poor sleep quality. This also conditions their mental health, with people reporting bad moods and lack of energy, mood swings, and lower levels of enthusiasm.

In Jelgava, they needed the heating on most of the year and had limited capacity to switch off the heating system; however, the interviewees had issues with the affordability of their energy bills. In the Obuda pilot, the house's condition was poor; they suffered from mould and inadequate ventilation. Financially, they are also dealing with a difficult situation where they have limited ability to provide for their families. Sometimes, they need support from family and friends to use electrical appliances (fridges, stoves) when broken, as they cannot afford to pay for repairs. This negatively affects their mental health, causing anxiety and even shame. At the physical level, interviewees reported that "something was not working OK with their health" and they would feel joint aches.

We also complement this section with three stories of the lived experiences of our interviewees on how they use different mechanisms to cope with the energy crisis. We have chosen Jelgava, Valencia, and Leeds.

Ilze.

Ilze lives with her five-year-old daughter in a two-room apartment in an un-renovated apartment building in Jelgava (Latvia). Since Ilze works from home, she needs comfortable conditions in the apartment. Ilze tries to provide them as much as possible, but she feels powerless when it comes to the public areas of the building and other residents. Last winter, the apartment was warm enough, but there have been times when she has had to turn on the oven to heat the rooms. There is some mould in the bathroom and near the windowsills, which indicates a poorly functioning ventilation system in the apartment.

For this reason, the apartment also often smells of cigarettes from other apartments, which forces her to ventilate the rooms regularly. Ilze has considered the rising energy cost and carefully plans her monthly budget. The family saves money on various entertainment activities to cope with heating and electricity bills and food prices, which have risen considerably due to inflation.

Hans (German) and Maica (South American).

Hans and Maica live together in a rented flat near the beach in Valencia (Spain). Javier's 8-year-old son lives with them for half of the time. Their house is cold and humid during winter, they do not have a heating system in the flat and must use electric radiators that they move from one room to another and electric blankets to keep warm, which use a lot of energy. The flat is also very hot in summer as it is badly insulated and has many draughts. They are afraid that the rent will go up if any renovation of the building is carried out. Maica suffers more from joint pain during winter due to the humidity and cold as she gets old. They have not yet applied for a social tariff but would like to do so. They try to save as much energy as possible to spend as little as possible because they are very aware of climate change.

Samantha.

Samantha, a nurse, lives with her 3 children (including one who is disabled) in a three-bedroom flat in Leeds (England). She has persistent dampness and mould in her house, which has a major effect on her wellbeing and health: she cannot sleep in her damp bedroom, and she experiences breathing difficulties associated with long COVID exacerbated by the mould. This year has been particularly hard for her and her family, with the additional cost of food and energy, and they have had to spend only on real necessities. Any savings she had are being used up on everyday living. Samantha was frustrated that she had to pay the disability benefits she receives for her youngest child on everyday items, including energy, so she could no longer take him to martial arts lessons.

Finally, we can mention that energy poverty is widespread among the participants, and winter 22-23 was difficult for them. The fact that most were not comfortably warm and that many are coping by rationing light and heat is evidence that support measures were inadequate for these people. People also showed a high level of anxiety and depression, likely related to these challenging circumstances.

Experiences varied across and within the pilots. Some of the respondents experience multiple social disadvantages: for example, being from an ethnic minority, being disabled or ill, as well as being on a low income with low education. Experiences are also shaped by state-provided heat (Latvia or Hungary), the lack of a heat infrastructure (Turkey, Spain), and the energy efficiency of homes. Poor housing conditions reported by our respondents emphasise the urgent need to tackle energy poverty and ill health by better-addressing housing standards and energy efficiency in public policy.

4. Conclusion

This Deliverable 4.2 presents the Intermediate Analysis of the WELLBASED evaluation study at Month 32 (October 2023) of the project. It includes data collected using self-report questionnaires, health monitoring, indoor air quality and interviews during baseline over the six participating pilot sites in Edirne, Heerlen, Jelgava, Leeds, Obuda and Valencia. The focus of Deliverable 4.2 was to provide a descriptive overview of the demographic characteristics, the health and well-being and the energy-poverty status of the WELLBASED study participants at baseline.

The WELLBASED study sample comprises of 1340 participants with informed consent. About two third of the participants is female and one third is male in both study groups. The average age is about 50 years. More than half of the participants is divorced, single or widowed and also two third indicated having no paid work. Half of the sample's participants are living in a flat or apartment and almost half is owner of their property.

Overall, the study sample showed lowered health and well-being in line with previous research among those living in energy-poverty (9, 10, 11). The data with regard to health and well-being indicated that a high level of the participants (almost 80%) in the study experienced one or more chronic conditions. According to European figures approximately 39% of the adult population suffers of one or more chronic conditions (12). On the health-related quality of life assessment about 30% reported moderate to severe problems in discomfort and anxiety/depression. This was in line with the findings on the mental health scales, with similar percentages of participants reporting higher levels of depression, anxiety and stress.

Among older people the frailty assessment indicated that among older people in the study, aged on average 73 years, the risk on frailty is considerable. Specifically, a higher score on co-morbidities and lack of co-habitation seemingly is associated with a high risk for frailty among older participants.

The health monitoring among intervention group participants indicated about a fifth of participants experiencing hypertension. The participants rated their overall sleep quality moderate to good. Up to now only the first three months of health monitoring data were available for a descriptive overview. In time, it will be possible to observe potential time trends in these health indicators.

In the WELLBASED study we assess specific energy-poverty indicators as well as strategies people use to deal with energy-poverty related issues such as heating and cooling. The data showed that most people use electricity as energy source (almost 95%). It appeared that it was difficult for participants to provide information with regard to costs, as there were many missing data. Besides the high level of missing data, the average costs and standard deviation indicated a high variability in costs. Therefore, for the follow-up

measurements the design of this measure will be reconsidered. About 30% of participants indicated receiving some sort of support towards paying their energy bills. It is likely that not all participants are aware or familiar with the opportunities to receive support towards paying the energy bill.

The energy poverty indicators we assed showed the high percentage of participants experiencing their home as un-comfortable in winter (60%) or in summer (70%). In total, around 47% indicated having arrears on utility bills. Eurostat (13) reported over 9.3% of Europeans being unable to keep their homes adequately warm in 2022. Moreover, in half of the houses in our study there was leak, damp or rot present. A quarter of people indicated not being satisfied with their home. In addition, the findings with regard to the energy-related coping strategies participants used contribute to the fact that the participants are struggling to make ends meet (14-17). Participants indicated taking several measures to deal with energy poverty such as wearing extra clothes, turning off the heating or cooling, and heating or cooling only one room of the house to save money. Around 10% visits public buildings to stay warm, or visits friends to keep warm or cool. Finally, 20% indicated going to bed in the daytime to keep warm.

A poorer indoor air quality is often unevenly experienced by lower socio-economic households, having an impact on health and well-being (18, 19).The indoor air quality data among the intervention group of the WELLBASED sample showed us trends including increasing/decreasing indoor temperatures mirroring outdoor temperatures. Graphs depicting the percentage of time households were above or below recommended thresholds flipped around with temperatures often surpassing the minimum threshold (18 degrees Celsius) in the winter and the maximum threshold (24 degrees Celsius) in the summer. Indoor CO_2 levels showed a declining trend when transitioning from winter to summer, potentially due to more ventilation in the home during summer by opening windows more frequently.

The qualitative work done to capture lived experiences confirms that the situation in the participating households is poor and people's health is affected. Moreover, there are relevant differences between pilot sites that need to be taken into account when interpreting data. The combination of different data sources on a broad range of indicators of energy-poverty, health and wellbeing is a strength of this study. For the evaluation of impact of the WELLBASED interventions we will have data over time and provide a comprehensive analysis that combines the insights from the different sources guided by Realist Evaluation.

Some methodological considerations need to be considered. First, the recruitment period for the WELLBASED study ended in July 1st 2023. The recruitment period was extended due to difficulties pilots experienced in including people in the study. In some cases, in some sites, the consent was signed but the baseline questionnaire was completed later in time. This may result in shorter follow-up periods, depending

on the exact timing of questionnaire completion. Follow-up data collection is monitored closely and appropriate actions are taken to keep the proposed timeline. Second, health monitoring data (peak flow, oxygen saturation (SpO_2), blood pressure and heart rate) were measured using different methodology across pilot sites (e.g. self-assessment by medical sensor devices, nurse/ research assistant/physician assessment). Future analyses will need to determine the comparability of the measures. However, given the limited possibilities to perform these measures in some pilot sites this flexibility in methodology was required. Also, not all participants in the intervention group perform or receive health monitoring and numbers for analyses can be low. Pilot sites report that participation in the health monitoring is challenging as it is intensive (i.e. one measure per month). We will continue to monitor adherence and discuss with pilot cities' teams potential actions to enhance adherence. Moreover, missing data, can be dealt with using statistical methods but may propose limitations to the analyses. Finally, up to now, only descriptive statistics were performed. In the next analyses more and complex analyses will be performed to provide more insight in the impact of energy poverty on health and especially the impact of the intervention performed in the WELLBASED program. Findings will be translated together with partners in policy and practice recommendations.

The intermediate analyses provide a first insight in the characteristics of demographics, health, well-being and energy-poverty among the participants in the WELLBASED study. To evaluate the impact of the WELLBASED interventions we foresee a comprehensive approach, guided by Realist Evaluation, in which the different data on energy-poverty, health and well-being, are combined and jointly interpreted.

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Annexes

Annex A: Edirne pilot-site

Socio-demographic characteristics

Table A1 presents the characteristics of Edirne pilot site participants. In total 50.2% were female, the average age was 44.7 years (SD 17.3), 88.0% did not have paid work.

Table A 1. Characteristics of participants n=241

Variable		
Socio-demographic		
Gender, n (%)		
	Female	121 (50.2%)
	Male	120 (49.8%)
	Prefer not to say	0
	Other	0
Age (years)		
	Mean (SD) [a]	44.7 (17.3)
	Older people (>65 years)	32 (13.3%)
Marital status, n (%)		
	Married	153 (63.5%)
	Single, separated, divorced or widowed	88 (36.5%)
Educational level, n (%) [b]		
	Post-secondary or lower	222 (92.1%)
	Higher education	17 (7.1%)
Household income category[c] *, n (%)*		
	1 (Less than 750€)	238 (98.8%)
	2 (751 € to under 1.000 €)	1 (0.4%)
	3 (1.001 € to under 1.300 €)	0
	4 (1.301 € to under 1.650 €)	0
	5 (1.651 € to under 2.000 €)	0
	6 (2.001 € to under 2.350 €)	0
	7 (2.351 € to under 2.800 €)	0
	8 (2.801 € to under 3.500€)	0

	9 (3.500 € or more)	0
Paid work, n(%)		
	Yes, by respondent [d]	22 (9.1%)
	Yes, by respondent's partner [e]	12 (5.0%)
	No[c]	212 (88%)
Household composition		
	Single-adult with children	4 (1.7%)
	Single-adult without children	2 (0.8%)
	Two or more adults with children	114 (47.3%)
	Two or more adults without children	121 (50.2%)
Migration background [f]		
	Yes	1 (0.4%)
	No	238 (98.8%)
*Belonging to an ethnic minority**		
Dwelling type [g]		
	Detached	240 (99.6%)
	Semi-detached/terraced	0
	Apartment or flat	0
	Other	0
Tenure status		
	Owner	241 (100.0%)
	Rented at market rate	0
	Reduced/free rent	0
	Other	0

* Not assessed

[a] 4 missing

[b] 2 missing

[c] 2 missing

[d] 7 (2.9%) missing

[e] 87 (36.1%) missing

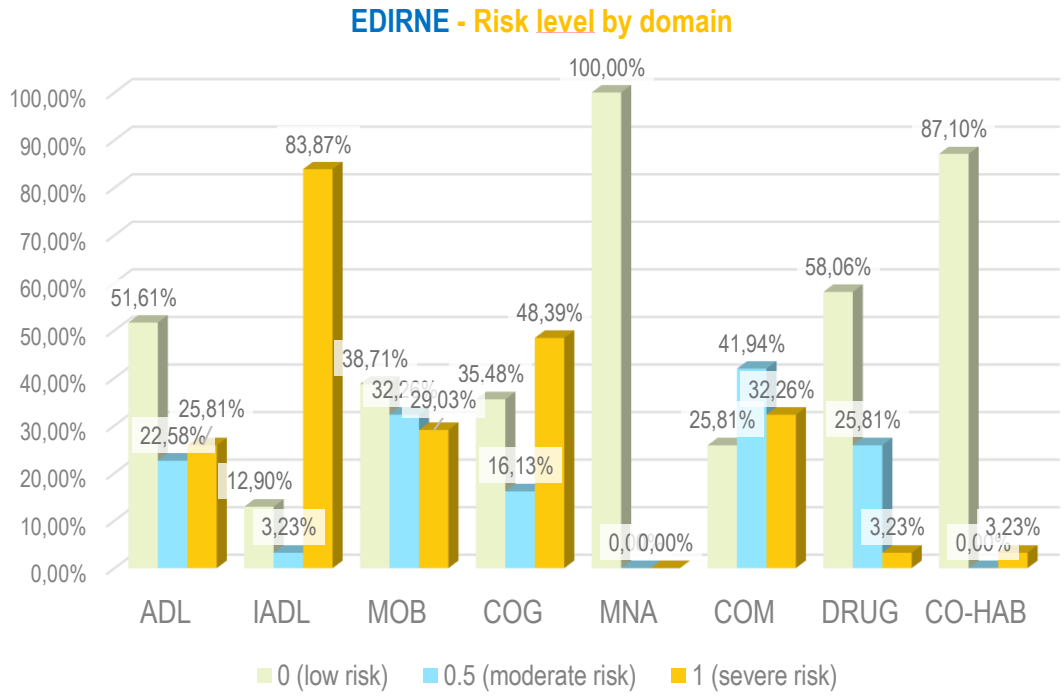
[f] 2 (0.8%) missing

[g] 1 (0.4%) missing

Risk level of frailty domains

Figure A1 shows results per frailty domains in Edirne pilot city. Edirne older participants (mean age= 73.81, SD= 7.59, female= 61.29%) are at high risk of Instrumental Activities of daily Living (IADL) and cognitive domains (83.37% and 48.39% respectively), and low risk in nutrition, number of drugs, and co-habitation domains (100%, 58.06% and 87.10% respectively).

Figure A 1. Risk level of frailty domains of the older group (n=31) aged ≥ 65



Energy-related coping strategies in the past 12 months

Table A2 presents coping strategies for energy-related issues in Edirne. 64.7% of the respondents indicate that they 'often or always' turn off heating or cooling to save money. 75.5% 'often or always' heat or cool only one room of the house to save money.

Table A 2. Energy coping behaviours in the past 12 months

Variable		*n* (%)
Turning heating/cooling off to save money[a]		
	Never or rarely	62 (25.7%)
	Sometimes	22 (9.1%)
	Often or always	156 (64.7%)
	Not an option in my dwelling	0
Heating/cooling only one room of the house to save money		
	Never or rarely	43 (17.8%)
	Sometimes	15 (6.2%)
	Often or always	182 (75.5%)
	Not an option in my dwelling	1 (0.4%)

Indoor air quality data

Figure A2 shows the average daily outdoor and indoor temperature across all households participating in Edirne, starting in January 2023 (winter) and ending in July 2023 (summer). The increased average outdoor temperatures due to seasonal difference are only reflected in average indoor household temperatures in the months of May and June. The maximum figures are high (>40 degrees) at some points, which should be further evaluated.

Figure A 2. Average daily indoor and outdoor temperature across all participating households in Edirne, including thresholds (min. 18 and max. 24 degrees Celsius)

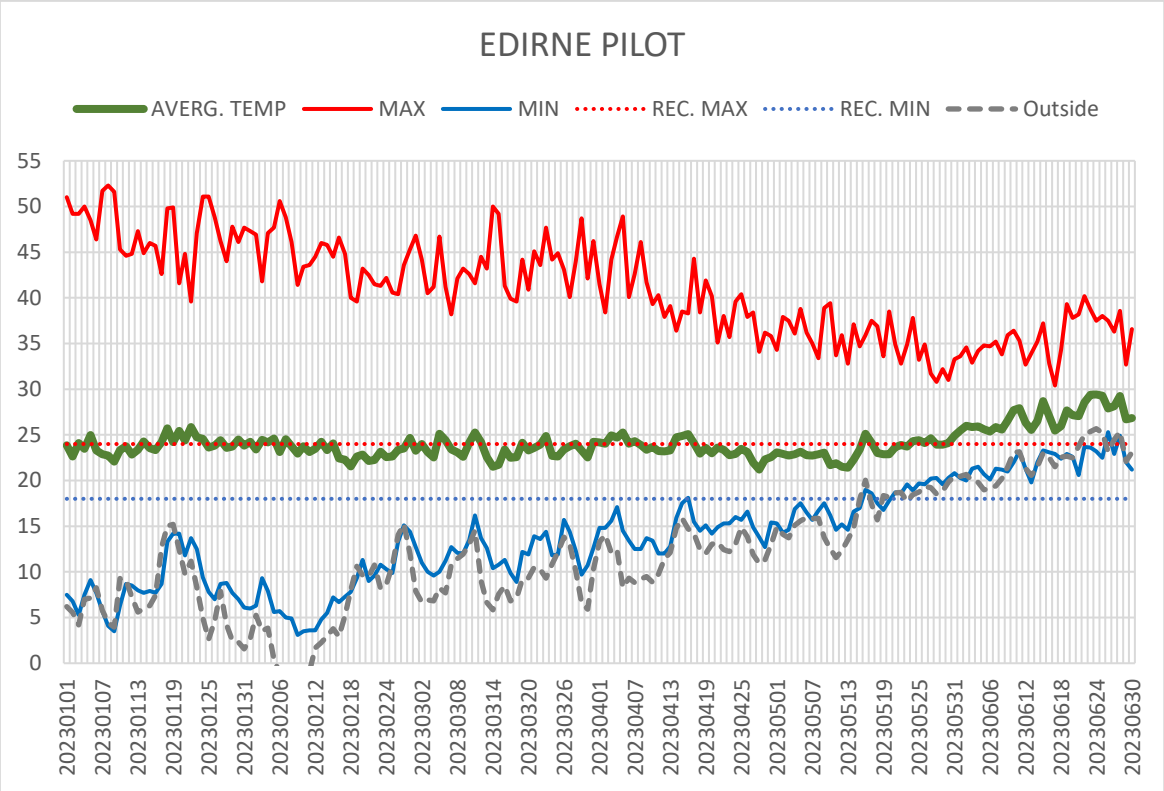


Figure A3 shows the percentage of time the temperatures remained below or above the recommended thresholds. During the winter period, the indoor temperatures were around 50% of the time above the recommended threshold of 24 degrees Celsius, but also around 30% of the time below the recommended threshold of 18 degrees Celsius. From Mid-May onwards, 30% to 100% of the time the indoor temperatures were above the recommended threshold of 24 degrees Celsius.

Figure A 3. Percentage of time with temperature above the recommended 24 degrees Celsius and below the recommended 18 degrees Celsius in Edirne

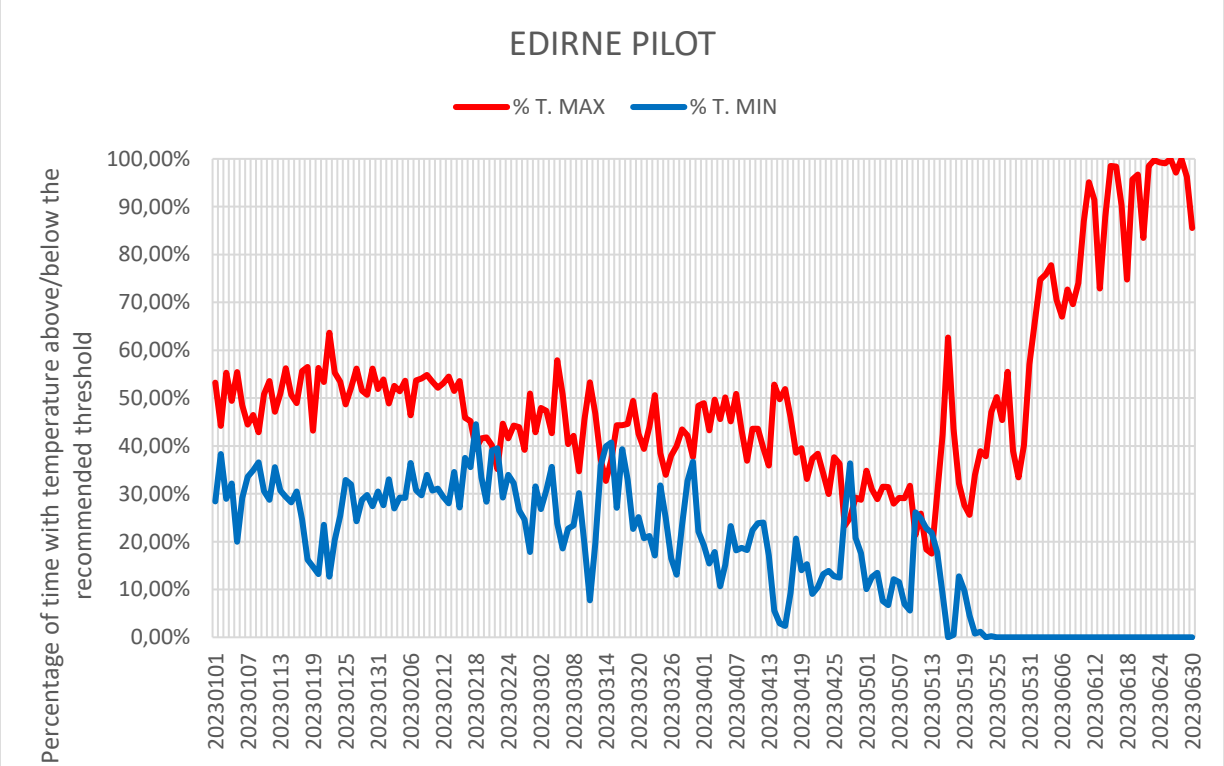


Figure A4 displays the average daily indoor humidity for all participating households in Edirne. Average indoor humidity consistently stays within recommended thresholds, while outdoor humidity typically exceeds 70%.

Figure A 4. Average daily indoor and outdoor humidity levels across households in Edirne including humidity thresholds (min 30%, max 70%)

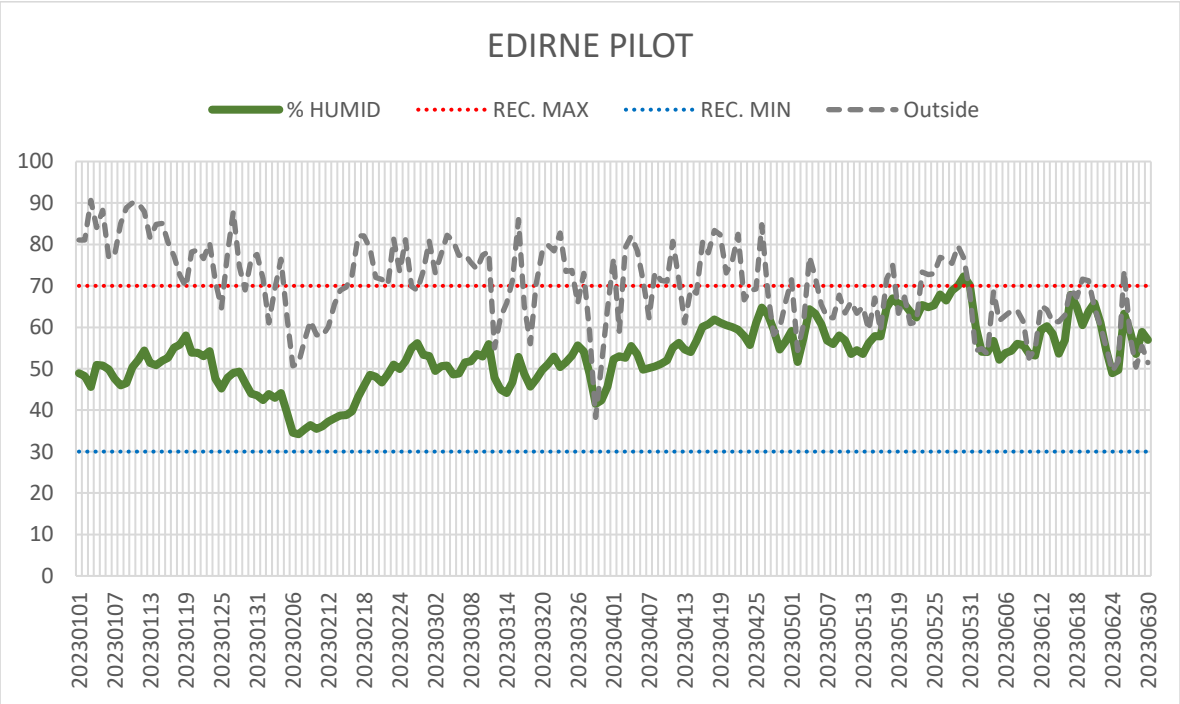
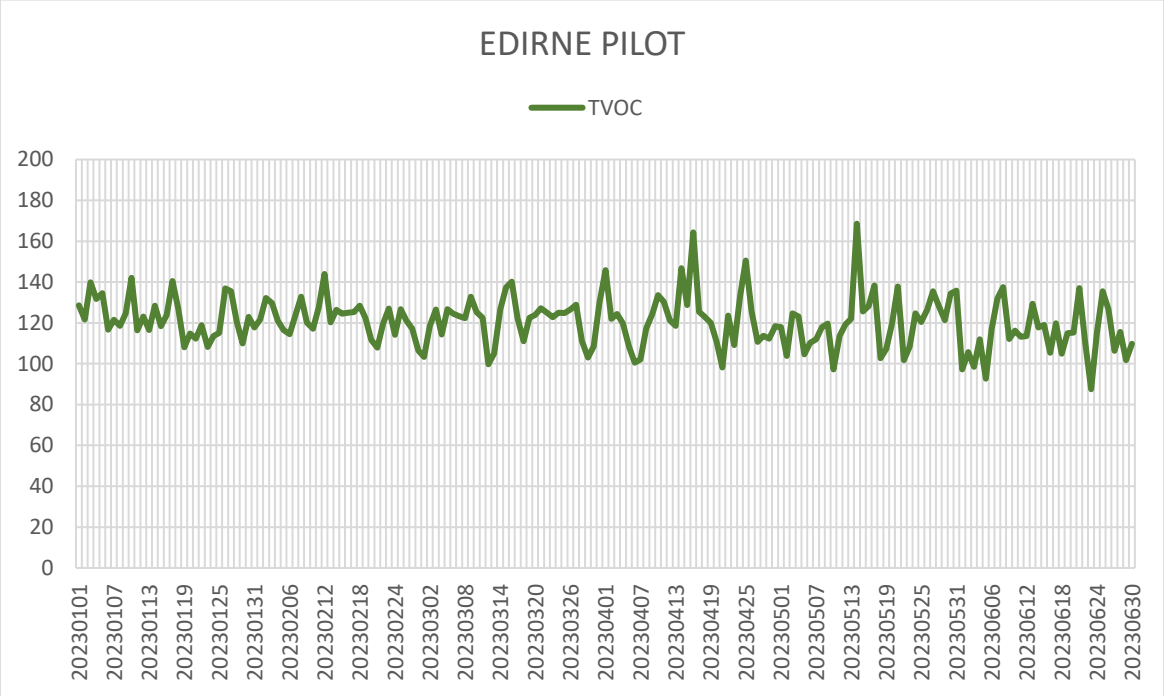


Figure A5 shows the average daily tVOC index in participating households in Edirne. The tVOC index shows the relative tVOC intensity on average over the last 24 hours, where a value of 100 is considered average tVOC intensity. All values below or above 100 are considered to be less intense than average or more intense than average respectively. Across all the households participating in the Edirne pilot site are experiencing a more intense tVOC than average, which stays roughly the same across the measurement period.

Figure A 5. Average daily tVOC index across households in Edirne



Annex B: Heerlen pilot-site

Socio-demographic characteristics

Table B1 presents the characteristics of Heerlen pilot site participants. In total 62.5% was female, the average age was 51.5 years (SD 14.5), 80.0% did not have paid work.

Table B 1. Characteristics of participants (n=160)

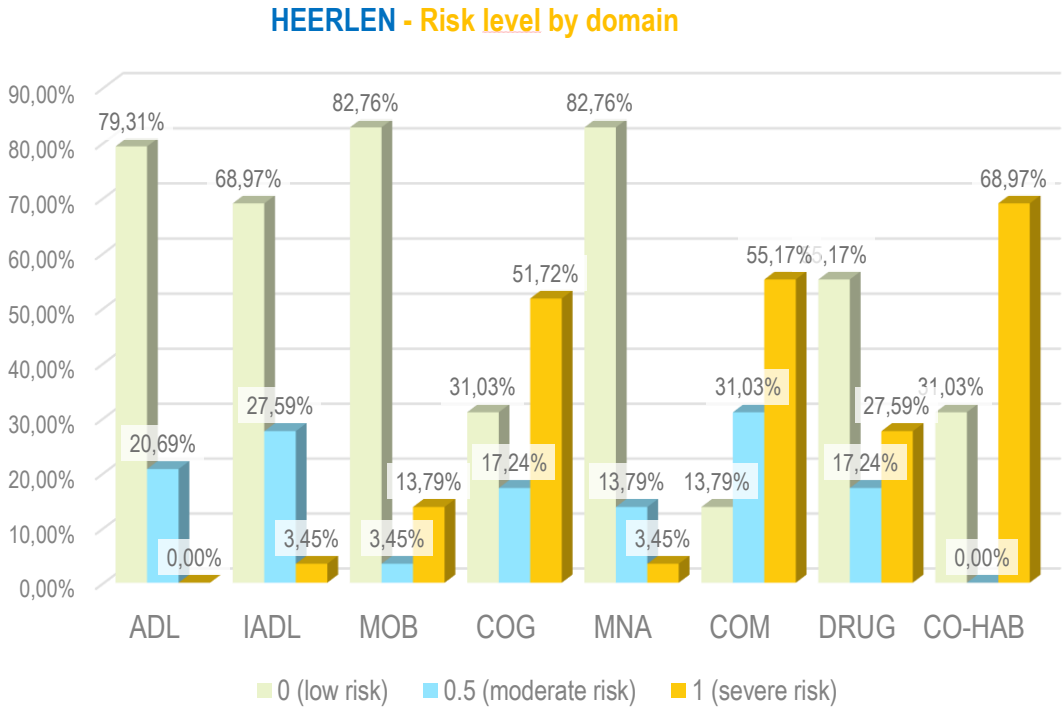
Variable		
Socio-demographic		
Gender, n (%)		
	Female	100 (62.5%)
	Male	58 (36.3%)
	Prefer not to say	0
	Other	2 (1.3%)
Age (years)		
	Mean (SD)	51.5 (14.5)
	Older people (>65 years)	24 (15.0%)
Marital status, n (%)		
	Married	42 (26.3)
	Single, separated, divorced or widowed	118 (73.8)
Educational level, n (%)		
	Post-secondary or lower	136 (85.0%)
	Higher education	24 (15.0%)
Household income category , n (%)		
	1 (Less than 750€)	19 (11.9%)
	2 (751 € to under 1.000 €)	12 (7.5%)
	3 (1.001 € to under 1.300 €)	50 (31.3%)
	4 (1.301 € to under 1.650 €)	32 (20.0%)
	5 (1.651 € to under 2.000 €)	20 (12.5%)
	6 (2.001 € to under 2.350 €)	9 (5.6%)
	7 (2.351 € to under 2.800 €)	12 (7.5%)
	8 (2.801 € to under 3.500€)	4 (2.5%)
	9 (3.500 € or more)	2 (1.3%)
Paid work, n(%)		
	Yes, by respondent[a]	29 (18.1%)

	Yes, by respondent's partner[b]	13 (8.1%)
	No[a]	128 (80.0 %)
Household composition		
	Single-adult with children	12 (10.9%)
	Single-adult without children	52 (47.3%)
	Two or more adults with children	15 (13.6%)
	Two or more adults without children	31 (28.2%)
Migration background		
	Yes	24 (15.0%)
	No	136 (85.0%)
Belonging to an ethnic minority		
	Yes	10 (6.3%)
	No	118 (73.8%)
	Prefer not to say/don't know	32 (20.0%)
Dwelling type		
	Detached	2 (1.8%)
	Semi-detached/terraced	69 (62.7%)
	Apartment or flat	37 (33.6%)
	Other	2 (1.8%)
Tenure status		
	Owner	10 (9.1%)
	Rented at market rate	16 (14.5%)
	Reduced/free rent	83 (75.5%)
	Other	1 (0.9%)
[a] 3 (1.9%) missing [b] 108 (67.5%) missing		

Risk level of frailty domains

Figure B1 shows results per frailty domains in Heerlen pilot city. Heerlen older participants (mean age= 71.86, SD= 6.57, female=48.28%) are at high risk of cognitive, comorbidities and co-habitation domains (51.72%, 56.17% and 68.97% respectively).

Figure B 1. Risk level of frailty domains of the older group (n=29) aged ≥ 65



Energy-related coping strategies in the past 12 months

Table B2 presents coping strategies for energy-related issues in Heerlen. 55.6% of the respondents indicate that they 'often or always' turn off heating or cooling to save money. 56.9% 'often or always' heat or cool only one room of the house to save money.

Table B 2. Energy coping behaviours in the past 12 months

Variable		*n* (%)
Turning heating/cooling off to save money		
	Never or rarely	31 (19.4%)
	Sometimes	40 (25.0%)
	Often or always	89 (55.6%)
	Not an option in my dwelling	0
Heating/cooling only one room of the house to save money		
	Never or rarely	36 (22.5%)
	Sometimes	29 (18.1%)
	Often or always	91 (56.9%)
	Not an option in my dwelling	4 (2.5%)

Indoor air quality data

Figure B2 shows the average daily outdoor and indoor temperature across all households participating in Heerlen, starting in January 2023 (winter) and ending in July 2023 (summer). The increased average outdoor temperatures due to seasonal difference is also reflected in the average indoor household temperatures. The maximum figures are high (>40 degrees) at some points, which should be further evaluated.

Figure B 2. Average daily indoor and outdoor temperature across all participating households in Heerlen, including thresholds (min. 18 and max. 24 degrees Celsius)

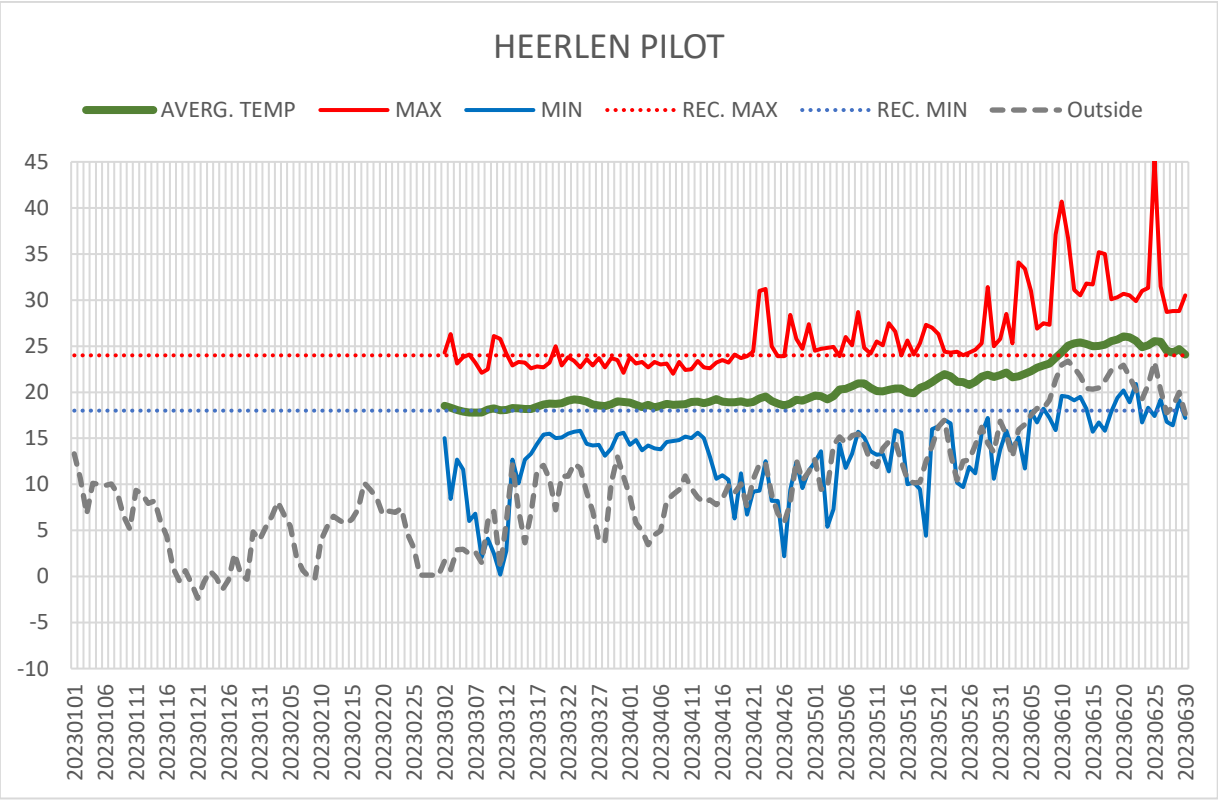


Figure B3 shows the percentage of time the temperatures remained below or above the recommended thresholds. During the winter period, the indoor temperatures were 40% to 20% of the time below the recommended threshold of 18 degrees Celsius. From June onwards, nearly 75% of the time the indoor temperatures were above the recommended threshold of 24 degrees Celsius.

Figure B 3. Percentage of time with temperature above the recommended 24 degrees Celsius and below the recommended 18 degrees Celsius in Heerlen.

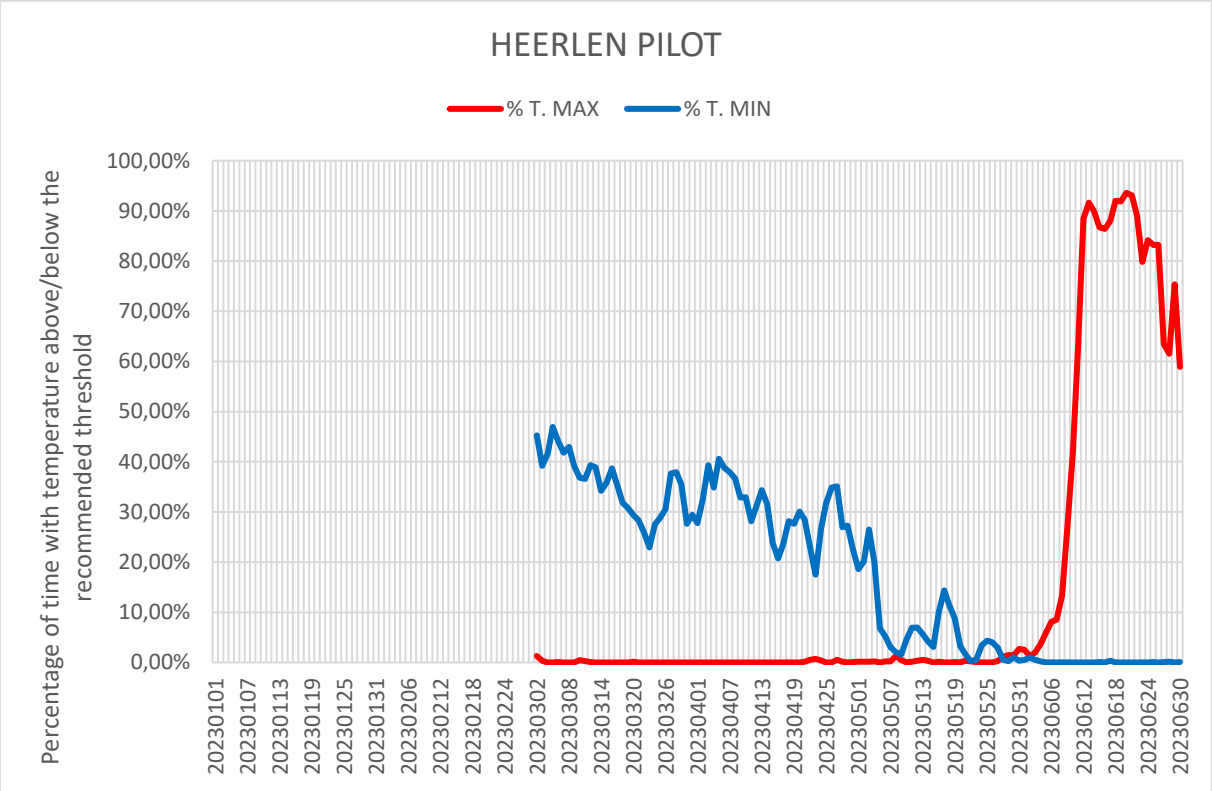


Figure B4 displays the average daily indoor humidity for all participating households in Heerlen. Average indoor humidity consistently stays within recommended thresholds, while outdoor humidity typically exceeds 70%. Figure B5 shows the average CO_2 levels in participating households in Heerlen. It demonstrates a seasonal trend, with higher daily CO_2 levels in the winter months and lower levels in summer.

Figure B 4. Average daily indoor and outdoor humidity levels across households in Heerlen including humidity thresholds (min 30%, max 70%)

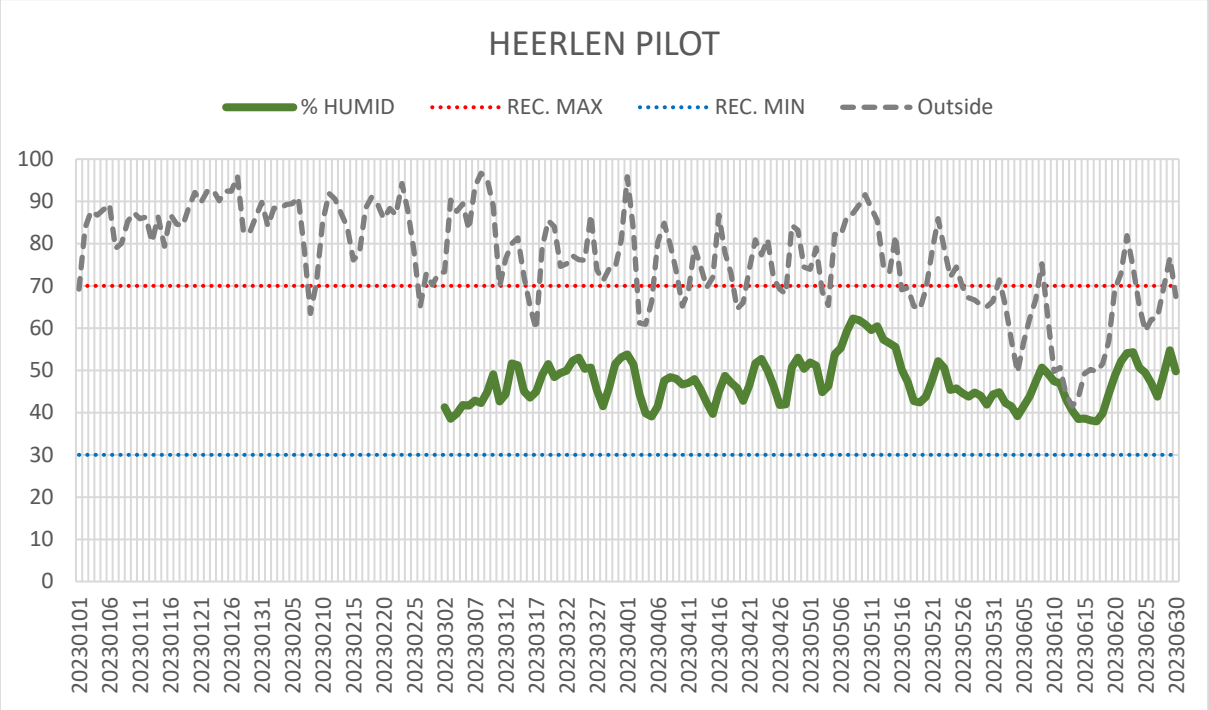
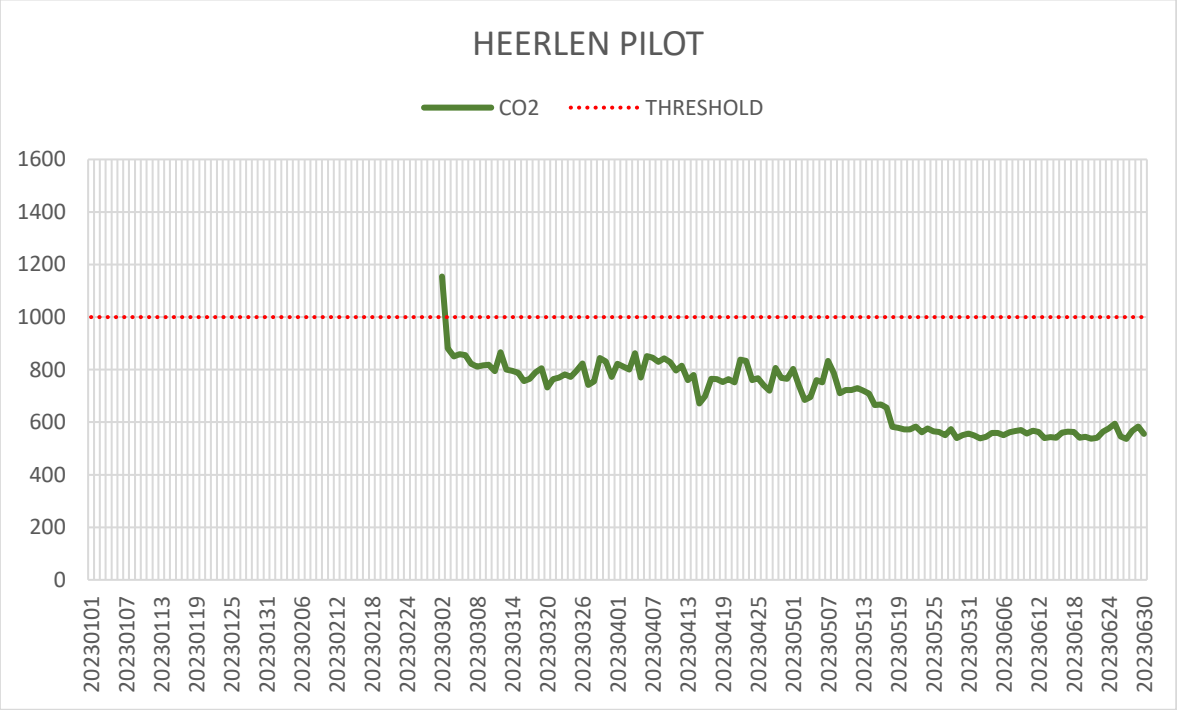


Figure B 5. Average daily CO2 levels across households in Heerlen including CO2 threshold of max. 1000 ppm



Annex C: Jelgava pilot site

Socio-demographic characteristics

Table C1 presents the characteristics of Jelgava pilot site participants. In total 73.7% was female, the average age was 53.95 years (SD 16.94), 30.1% did not have paid work.

Table C 1. Characteristics of participants (n=156)

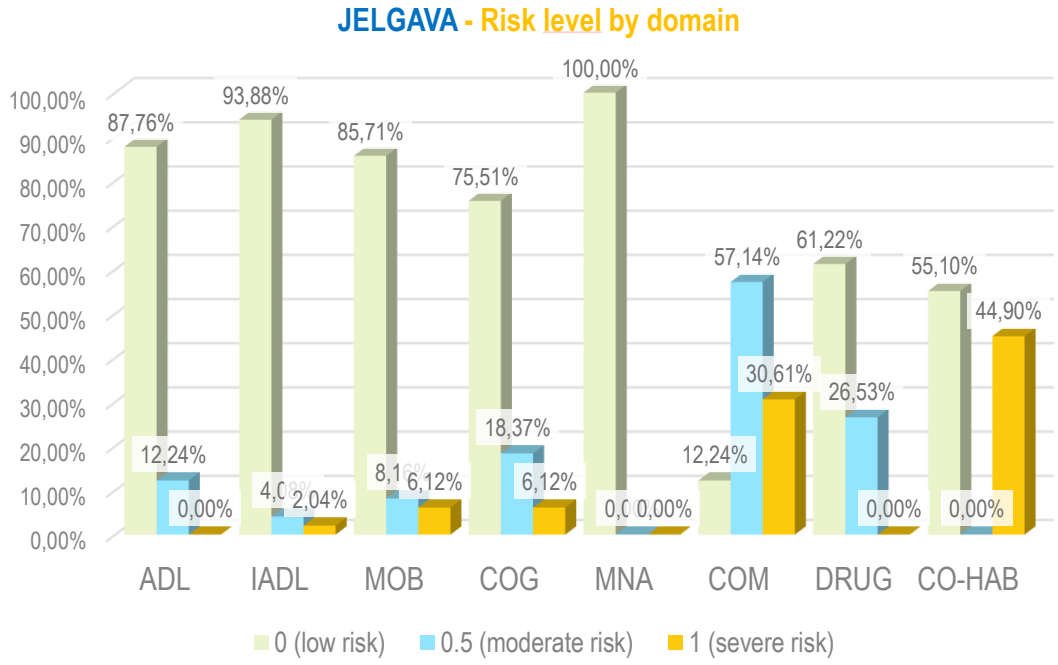
Variable		
Socio-demographic		
Gender, n (%)		
	Female	115 (73.7%)
	Male	41 (26.3%)
	Prefer not to say	0
	Other	0
Age (years)		
	Mean (SD)	53.95 (16.94)
	Older people (>65 years)	47 (30.1%)
Marital status, n (%)		
	Married	93 (59.6%)
	Single, separated, divorced or widowed	63 (40.4%)
Educational level, n (%)		
	Post-secondary or lower	2 (1.3%)
	Higher education	154 (98.7%)
Household income category, n (%)		
	1 (Less than 750€)	14 (9.0%)
	2 (751 € to under 1.000 €)	10 (6.4%)
	3 (1.001 € to under 1.300 €)	14 (9.0%)
	4 (1.301 € to under 1.650 €)	12 (7.7%)
	5 (1.651 € to under 2.000 €)	10 (6.4%)
	6 (2.001 € to under 2.350 €)	17 (10.9%)
	7 (2.351 € to under 2.800 €)	26 (16.7%)
	8 (2.801 € to under 3.500€)	26 (16.7%)
	9 (3.500 € or more)	27 (17.3%)
Paid work, n(%)		
	Yes, by respondent	109 (69.9%)

	Yes, by respondent's partner[a]	80 (51.3%)
	No	47 (30.1%)
Household composition		
	Single-adult with children	4 (2.6%)
	Single-adult without children	39 (25.0%)
	Two or more adults with children	53 (34.0%)
	Two or more adults without children	60 (38.5%)
Migration background		
	Yes	5 (3.2%)
	No	151 (96.8%)
Belonging to an ethnic minority		
	Yes	7 (4.5%)
	No	147 (94.2%)
	Prefer not to say/don't know	2 (1.2%)
Dwelling type		
	Detached	54 (34.6%)
	Semi-detached/terraced	1 (0.6%)
	Apartment or flat	101 (64.7%)
	Other	0
Tenure status		
	Owner	121 (77.6%)
	Rented at market rate	13 (8.3%)
	Reduced/free rent	18 (11.5%)
	Other	4 (2.6%)
[a] 54 (48.6%) missing		

Risk level of frailty domains

Figure C1 shows results per frailty domains in Jelgava pilot city. Jelgava older participants (mean age= 73.9, SD= 6.33, female=79.59%) are at low risk of Activities of Daily Living (ADL), Instrumental Activities of Daily Living (ADL) and Nutrition (MNA) domains (87.76%, 93.88% and 100% respectively).

Figure C 1. Risk level of frailty domains of the older group (n=49) aged ≥ 65



Energy-related coping strategies in the past 12 months

Table C2 presents coping strategies for energy-related issues in Jelgava. It is shown that just above 25% do not have the option to turn off heating/cooling to save money. Around 60% of the respondents indicate to never or rarely turn off heating/cooling to save money.

Table C 2. Energy coping strategies in the past 12 months

Variable		*n* (%)
Turning heating/cooling off to save money		
	Never or rarely	99 (63.5%)
	Sometimes	8 (5.1%)
	Often or always	8 (5.1%)
	Not an option in my dwelling	41 (26.3%)
Heating/cooling only one room of the house to save money		
	Never or rarely	103 (66.0%)
	Sometimes	3 (1.9%)
	Often or always	6 (3.8%)
	Not an option in my dwelling	44 (28.2%)

Indoor air quality data

Figure C2 shows the average daily outdoor and indoor temperature across all households participating in Jelgava, starting in January 2023 (winter) and ending in July 2023 (summer). The daily average temperature only exceeds the 24 degrees Celsius threshold mid-June. The maximum figures are high (>40 degrees) at some points, which should be further evaluated.

Figure C 2. Average daily indoor and outdoor temperature across all participating households in Jelgava, including thresholds (min. 18 and max. 24 degrees Celsius)

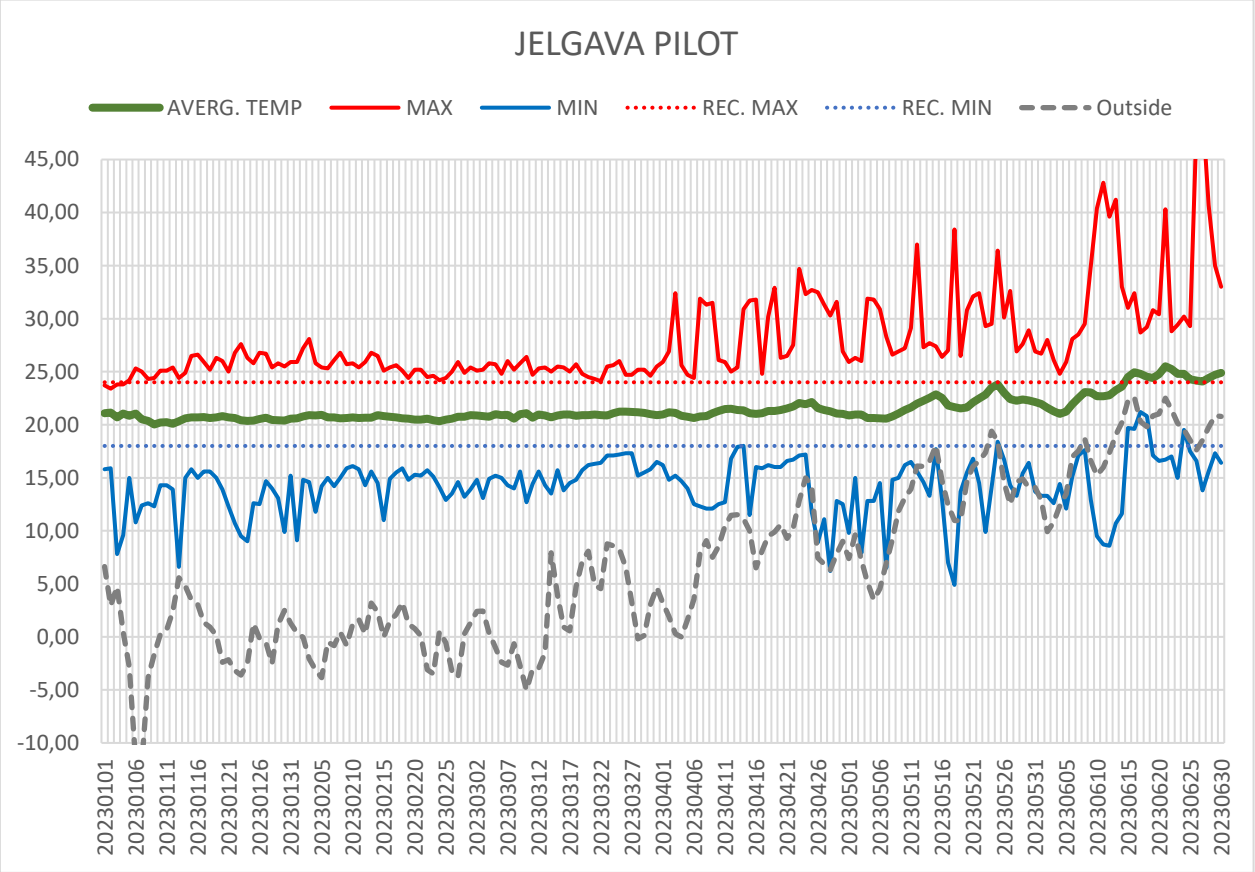


Figure C3 shows the percentage of time the temperatures remained below or above the recommended thresholds. During the winter period, the indoor temperature was about 10% of the time below the recommended threshold of 18 degrees Celsius. From June onwards the maximum threshold started to get exceeded from 30% to 80% of the time.

Figure C 3. Percentage of time with temperature above the recommended 24 degrees Celsius and below the recommended 18 degrees Celsius in Jelgava

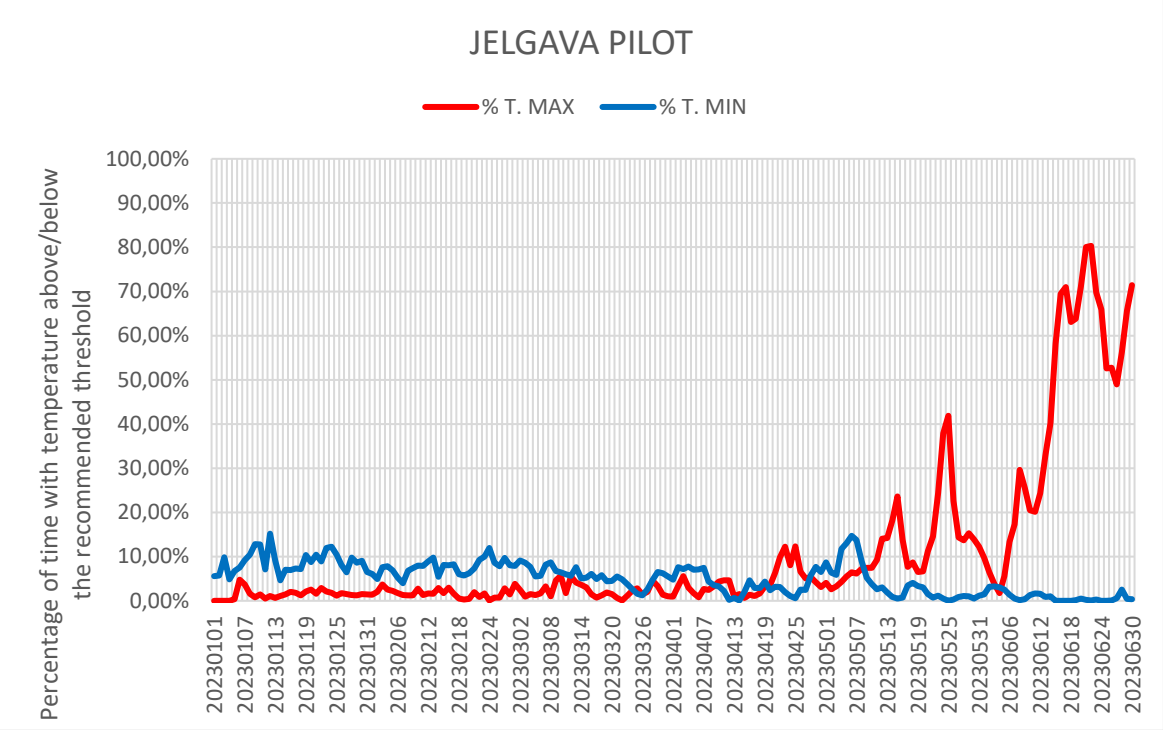


Figure C4 displays the average daily indoor humidity for all participating households in Jelgava. Average indoor humidity consistently stays within recommended thresholds. Figure C5 shows the average CO_2 levels in participating households in Jelgava. It demonstrates a seasonal trend, with higher daily CO_2 levels in the winter and lower levels in summer.

Figure C 4. Average daily indoor and outdoor humidity levels across households in Jelgava including humidity thresholds (min 30%, max 70%)

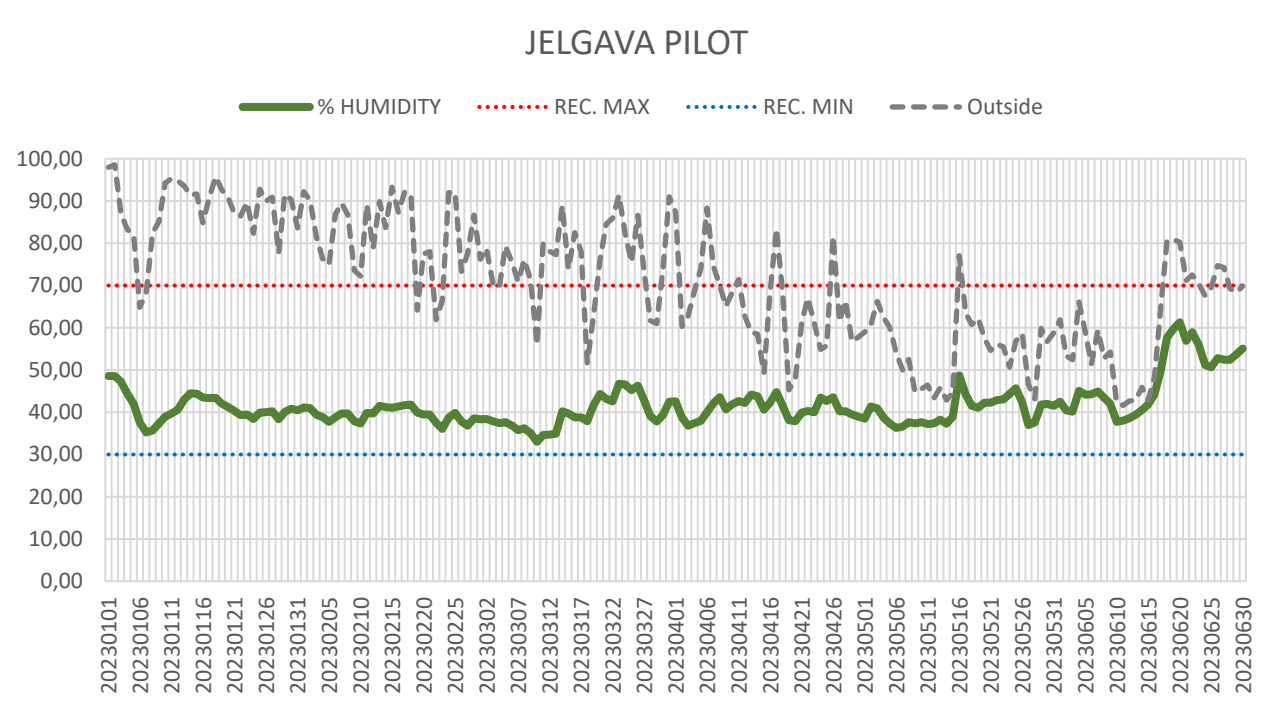
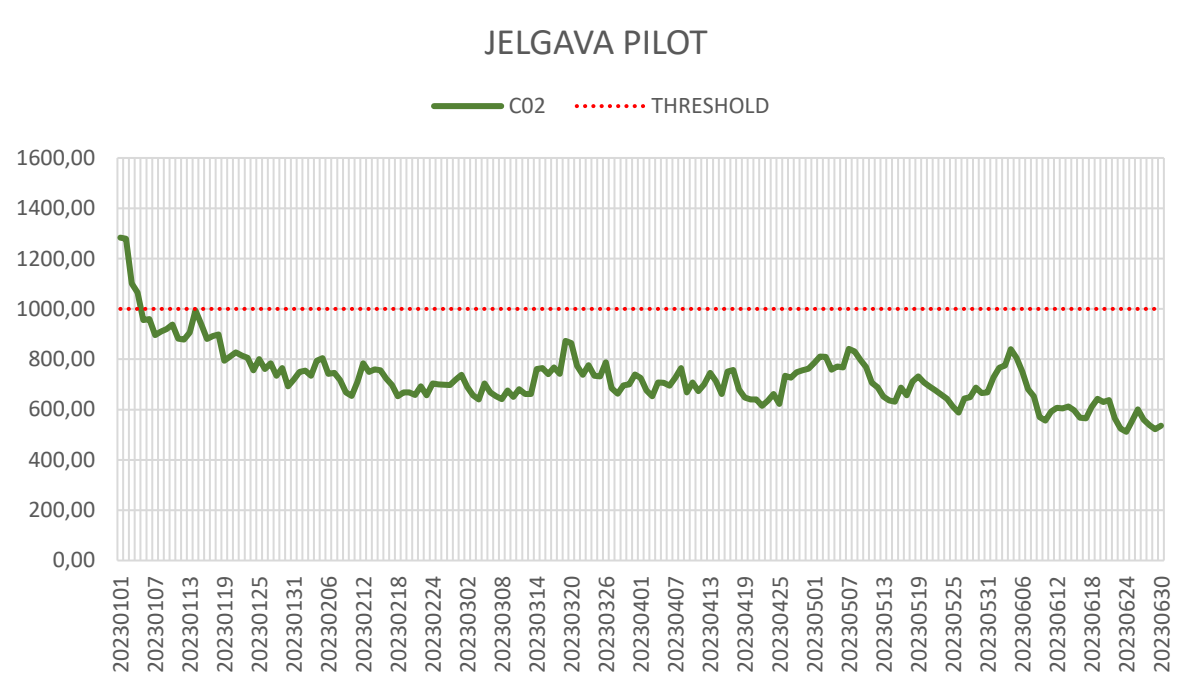


Figure C 5. Average daily CO_2 levels across households in Jelgava including CO_2 threshold of max. 1000 ppm



Annex D: Leeds pilot site

Socio-demographic characteristics

Table D1 presents the characteristics of Leeds pilot site participants. In total 68.6% was female, the average age was 46.7 years (SD 13.5), 57.1% did not have paid work

Table D 1. Characteristics of participants (n=191)

Socio-demographic	
Gender, n (%)	
Female	131 (68.6%)
Male	60 (31.4%)
Prefer not to say	0
Other	0
Age (years)	
Mean (SD)	46.7 (13.5)
Older people (>65 years)	16 (8.4%)
Marital status, n (%)	
Married	35 (18.3%)
Single, separated, divorced or widowed	156 (81.7%)
Educational level, n (%)	
Post-secondary or lower	101 (52.9%)
Higher education	90 (47.1%)
Household income category, n (%)	
1 (Less than 750€)	36 (18.8%)
2 (751 € to under 1.000 €)	41 (21.5%)
3 (1.001 € to under 1.300 €)	31 (16.2%)
4 (1.301 € to under 1.650 €)	29 (15.2%)
5 (1.651 € to under 2.000 €)	9 (4.7%)
6 (2.001 € to under 2.350 €)	11 (5.8%)
7 (2.351 € to under 2.800 €)	7 (3.7%)
8 (2.801 € to under 3.500€)	4 (2.1%)
9 (3.500 € or more)	23 (12.0%)
Paid work, n(%)	
Yes, by respondent[a]	73 (38.2%)
Yes, by respondent's partner[b]	22 (11.5%)

	No[a]	109 (57.1%)
Household composition[c]		
	Single-adult with children	34 (18.8%)
	Single-adult without children	60 (33.1%)
	Two or more adults with children	32 (17.7%)
	Two or more adults without children	35 (19.3%)
Migration background		
	Yes	16 (8.4%)
	No	175 (91.6%)
Belonging to an ethnic minority		
	Yes	22 (11.5%)
	No	153 (80.1%)
	Prefer not to say/don't know	16 (8.4%)
Dwelling type		
	Detached	3 (1.7%)
	Semi-detached/terraced	91 (50.3%)
	Apartment or flat	58 (32.0%)
	Other	10 (5.5%)
Tenure status[e]		
	Owner	3 (1.7%)
	Rented at market rate	66 (36.5%)
	Reduced/free rent	91 (50.3%)
	Other	2 (1.1%)

[a] 9 (4.7%) missing

[b] 126 (66.0%) missing

[c] 20 (11.0%) missing

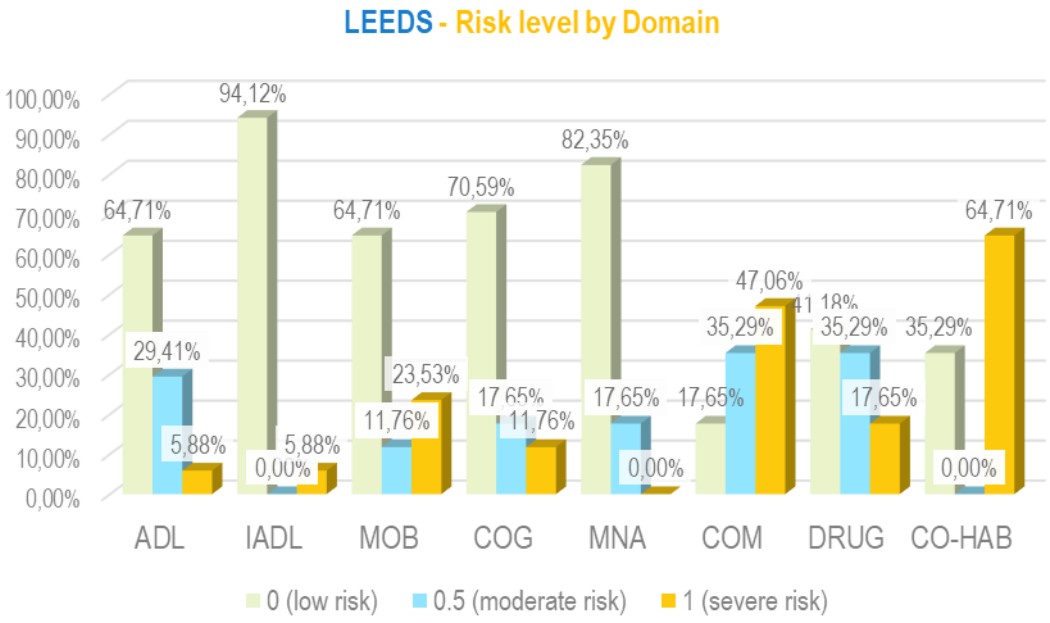
[d] 19 (10.5%) missing

[e] 19 (10.5%) missing

Risk level of frailty domains

Figure D1 shows results per frailty domains in Leeds pilot city. Leeds older participants (mean age= 70.53, SD= 4.21, female= 47.06%) are at high risk of co-morbities and co-habitation domains (47.06% and 64.71% respectively), and moderate risk in number of drug domain (35.29%).

Figure D 1. Risk level of frailty domains of the older group (n=17) aged ≥ 65



Energy-related coping strategies in the past 12 months

Table D2 presents coping strategies for energy-related issues in Leeds. 69.6% of the respondents indicate that they 'often or always' turn off heating or cooling to save money. Just above 50% 'often or always' heat or cool only one room of the house to save money.

Table D 2. Energy coping behaviours in the past 12 months

Variable		*n* (%)
Turning heating/cooling off to save money		
	Never or rarely	23 (12.0%)
	Sometimes	34 (17.8%)
	Often or always	133 (69.6%)
	Not an option in my dwelling	1 (0.5%)
Heating/cooling only one room of the house to save money		
	Never or rarely	62 (32.5%)
	Sometimes	26 (13.6%)
	Often or always	96 (50.3%)
	Not an option in my dwelling	7 (3.7%)

Indoor air quality data

Figure D2 shows the average daily outdoor and indoor temperature across all households participating in Leeds, starting in January 2023 (winter) and ending in July 2023 (summer). The increased average outdoor temperatures due to seasonal difference is also reflected in the average indoor household temperatures.

Figure D 2. Average daily indoor and outdoor temperature across all participating households in Leeds, including thresholds (min. 18 and max. 24 degrees Celsius)

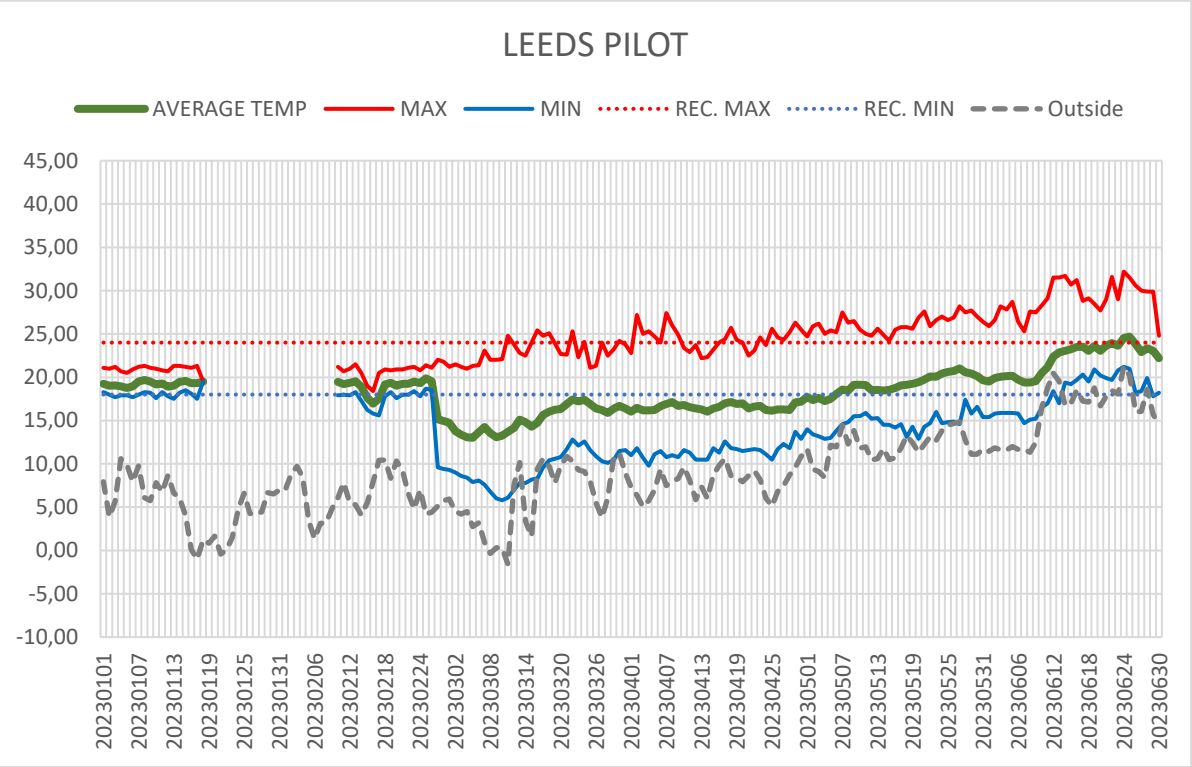


Figure D3 shows the percentage of time the temperatures remained below or above recommended thresholds. Until May, indoor temperatures were below the recommended 18 degrees Celsius threshold approximately 50% of the time. Starting mid-June onwards, indoor temperatures consistently exceeded the recommended 24 degrees Celsius threshold, typically around 30% of the time with a peak of 65%. Figure D4 displays the average daily indoor humidity for all participating households in Leeds. Average indoor humidity consistently stays within recommended thresholds, while outdoor humidity typically exceeds 70%.

Figure D 3. Percentage of time with temperature above the recommended 24 degrees Celsius and below the recommended 18 degrees Celsius in Leeds

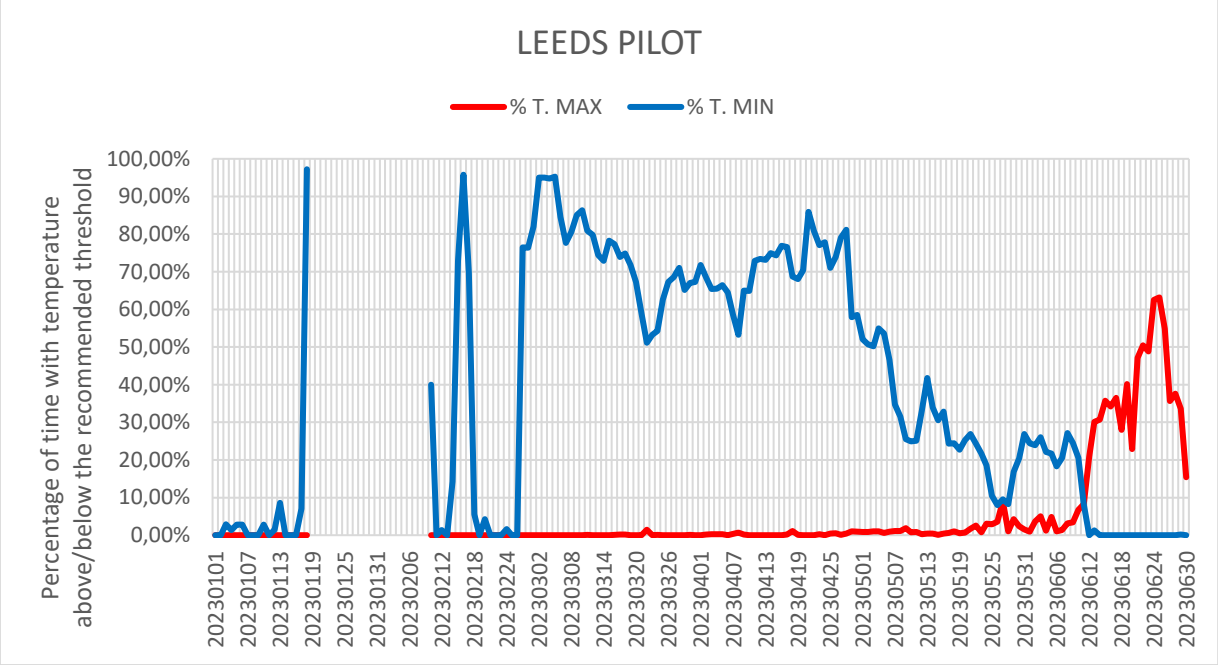
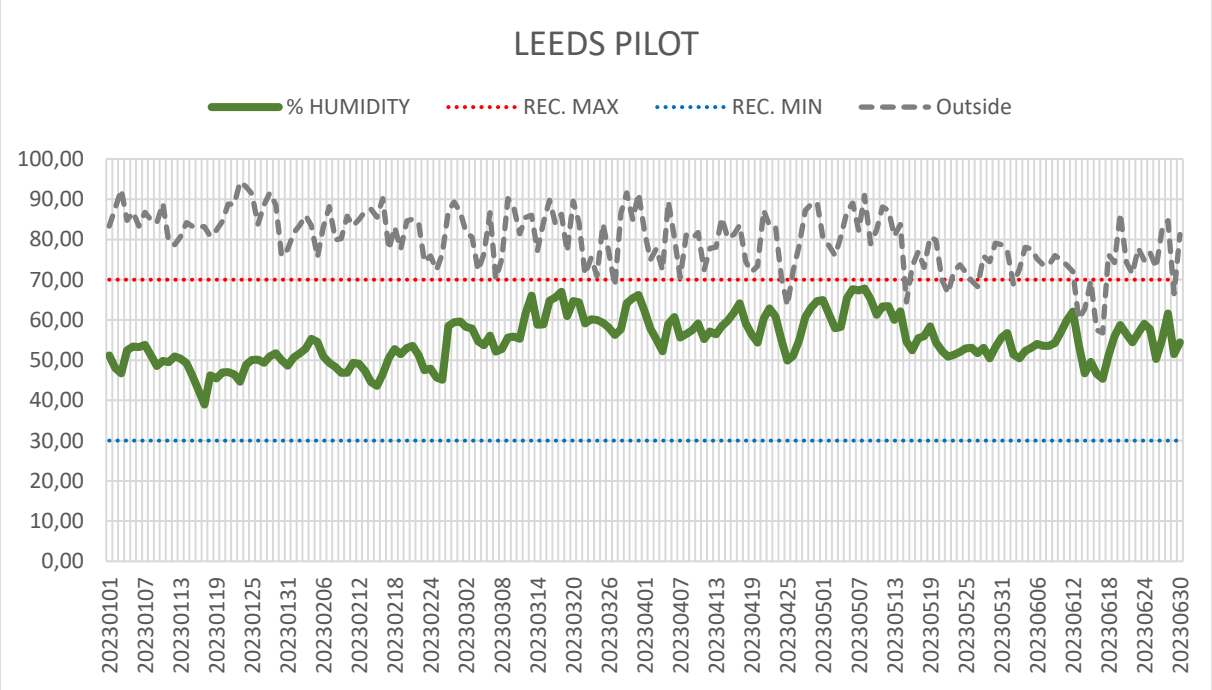


Figure D 4. Average daily indoor and outdoor humidity levels across households in Leeds including humidity thresholds (min 30%, max 70%)



Annex E: Obuda pilot site

Socio-demographic characteristics

Table E1 presents the characteristics of Obuda pilot site participants. In total 70.3% was female, the average age was 56.7 years (SD 18.3), 50.5% did not have paid work.

Table E 1. Characteristics of participants n=111

Variable		
Socio-demographic		
Gender, n (%)		
	Female	78 (70.3%)
	Male	33 (29.7%)
	Prefer not to say	0
	Other	0
Age (years)		
	Mean (SD)	56.7 (18.3)
	Older people (>65 years)	48 (43.2%)
Marital status, n (%)		
	Married	27 (24.3%)
	Single, separated, divorced or widowed	84 (75.7%)
Educational level, n (%)		
	Post-secondary or lower	22 (19.8%)
	Higher education	89 (80.2%)
Household income category, n (%)		
	1 (Less than 750€)	56 (50.5%)
	2 (751 € to under 1.000 €)	20 (18.0%)
	3 (1.001 € to under 1.300 €)	14 (12.6%)
	4 (1.301 € to under 1.650 €)	8 (7.2%)
	5 (1.651 € to under 2.000 €)	4 (3.6%)
	6 (2.001 € to under 2.350 €)	5 (4.5%)
	7 (2.351 € to under 2.800 €)	3 (2.7%)
	8 (2.801 € to under 3.500€)	0
	9 (3.500 € or more)	1 (0.9%)
Paid work, n(%)		
	Yes, by respondent[a]	53 (47.7%)

	Yes, by respondent's partner[b]	28 (25.2%)
	No[a]	56 (50.5%)
Household composition[c]		
	Single-adult with children	1 (1.2%)
	Single-adult without children	55 (64.0%)
	Two or more adults with children	13 (15.1%)
	Two or more adults without children	15 (17.4%)
Migration background		
	Yes	5 (4.5%)
	No	106 (95.5%)
Belonging to an ethnic minority		
	Yes	1 (0.9%)
	No	104 (93.7%)
	Prefer not to say/don't know	6 (5.4%)
Dwelling type		
	Detached	4 (4.7%)
	Semi-detached/terraced	4 (4.7%)
	Apartment or flat	66 (76.7%)
	Other	12 (14.0%)
Tenure status		
	Owner	40 (46.5%)
	Rented at market rate	17 (19.8%)
	Reduced/free rent	23 (26.7%)
	Other	6 (7.0%)

[a] 2 (1.8%) missing

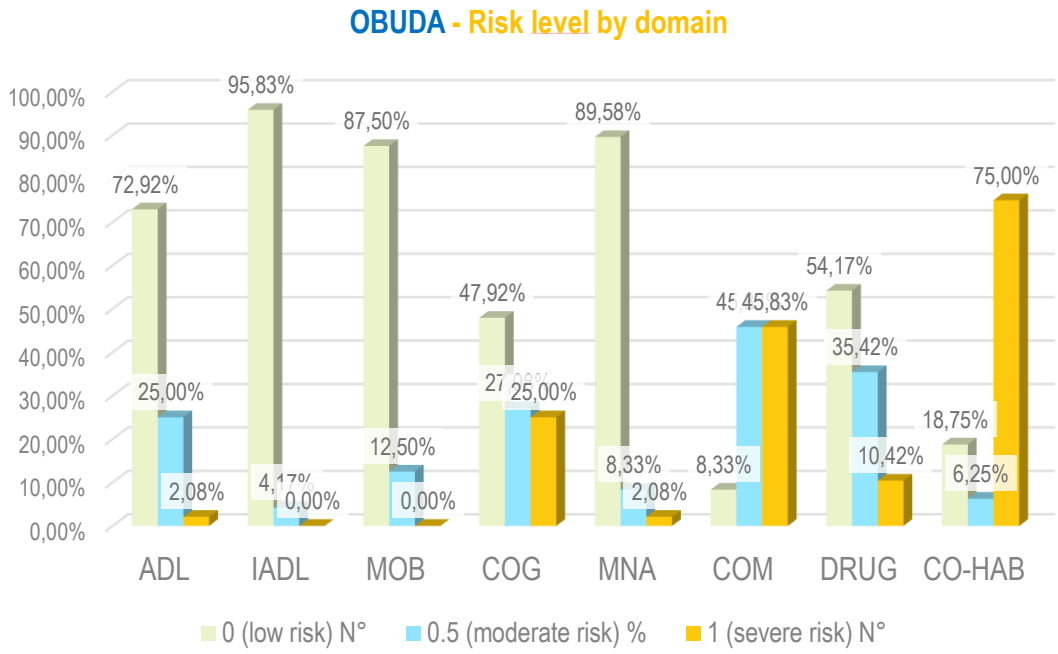
[b] 54 (48.6%) missing

[c] 2 (2.3%) missing

Risk level of frailty domains

Figure E1 shows results per frailty domains in Obuda pilot city. Obuda older participants (mean age= 74.54, SD= 5.10, female=87.50%) are at low risk of Instrumental Activities of Daily Living (ADL) and Nutrition (MNA) domains (95.83% and 89.58% respectively) and in a high risk of co-habitation status (75%).

Figure E 1. Risk level of frailty domains of the older group (n=48) aged ≥ 65



Energy-related coping strategies in the past 12 months

Table E2 presents coping strategies for energy-related issues in Obuda. 45.9% of the respondents indicate that they 'often or always' turn off heating or cooling to save money. 54.1% indicate to 'never or rarely' heat or cool only one room of the house to save money.

Table E 2. Energy coping strategies in the past 12 months

Variable		*n* (%)
Turning heating/cooling off to save money		
	Never or rarely	41 (36.9%)
	Sometimes	9 (8.1%)
	Often or always	51 (45.9%)
	Not an option in my dwelling	10 (9.0%)
Heating/cooling only one room of the house to save money		
	Never or rarely	60 (54.1%)
	Sometimes	6 (5.4%)
	Often or always	28 (25.2%)
	Not an option in my dwelling	17 (15.3%)

Annex F: Valencia pilot site

Socio-demographic characteristics

Table F1 presents the characteristics of Valencia pilot site participants. In total 69.6% was female, the average age was 48.8 years (SD 14.1), 62.7% did not have paid work.

Table F 1. Characteristics of participants (n=322)

Socio-demographic		
Gender, n (%)		
	Female	224 (69.6%)
	Male	97 (30.1%)
	Prefer not to say	1 (0.3%)
	Other	0
Age (years)		
	Mean (SD)	48.8 (14.1)
	Older people (>65 years)	35 (10.9%)
Marital status, n (%)		
	Married	152 (47.2%)
	Single, separated, divorced or widowed	170 (52.8%)
Educational level, n (%)		
	Post-secondary or lower	162 (50.3%)
	Higher education	160 (49.7%)
Household income category, n (%)		
	1 (Less than 750€)	150 (46.6%)
	2 (751 € to under 1.000 €)	68 (21.1%)
	3 (1.001 € to under 1.300 €)	51 (15.8%)
	4 (1.301 € to under 1.650 €)	25 (7.8%)
	5 (1.651 € to under 2.000 €)	9 (2.8%)
	6 (2.001 € to under 2.350 €)	6 (1.9%)
	7 (2.351 € to under 2.800 €)	2 (0.6%)
	8 (2.801 € to under 3.500€)	4 (1.2%)
	9 (3.500 € or more)	7 (2.2%)
Paid work, n(%)		
	Yes, by respondent[a]	102 (31.7%)
	Yes, by respondent's partner[b]	67 (20.8%)

	No[a]	202 (62.7%)
Household composition[c]		
	Single-adult with children	23 (7.2%)
	Single-adult without children	37 (11.6%)
	Two or more adults with children	111 (34.8%)
	Two or more adults without children	134 (42.0%)
Migration background		
	Yes	204 (63.4%)
	No	118 (36.6%)
Belonging to an ethnic minority		
	Yes	10 (3.1%)
	No	230 (71.4%)
	Prefer not to say/don't know	82 (25.5%)
Dwelling type[d]		
	Detached	2 (0.6%)
	Semi-detached/terraced	2 (0.6%)
	Apartment or flat	298 (93.4%)
	Other	3 (0.9%)
Tenure status[e]		
	Owner	63 (19.7%)
	Rented at market rate	164 (51.4%)
	Reduced/free rent	55 (17.2%)
	Other	23 (7.2%)

[a] 18 (5.6%) missing

[b] 154 (47.8%) missing

[c] 14 (4.4%) missing

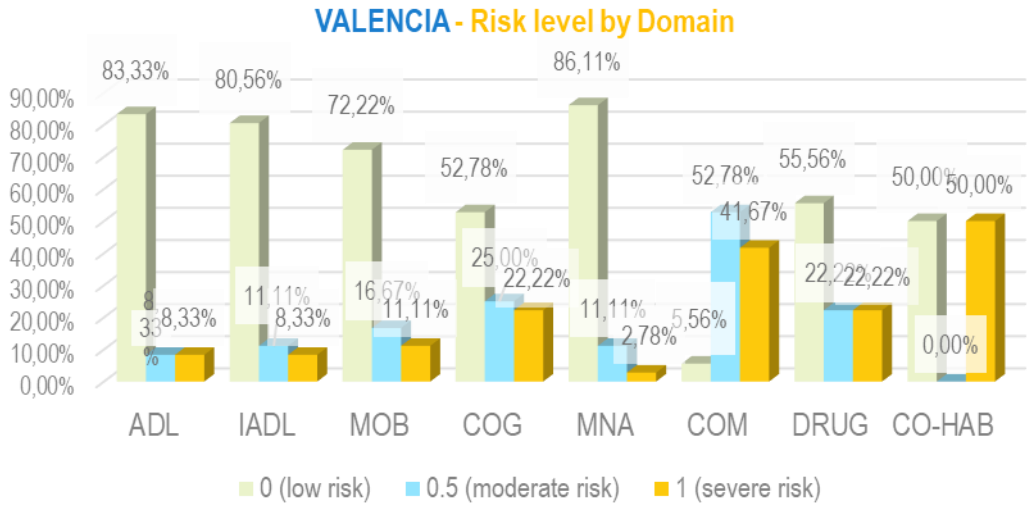
[d] 14 (4.4%) missing

[e] 14 (4.4%) missing

Risk level of frailty domains

Figure F1 shows results per frailty domains in Valencia pilot city. Valencia older participants (mean age= 74.19, SD= 6.20, female= 69.44%) are at high risk of comorbidities and co-habitation domains (22.22% and 50% respectively).

Figure F 1. Risk level of frailty domains of the older group (n=36) aged ≥ 65



Energy-related coping strategies in the past 12 months

Table F2 presents coping strategies for energy-related issues in Valencia. It is shown that just above 50% does not have the option to turn of heating/cooling to save money.

Table F 2. Energy coping strategies in the past 12 months

Variable		*n* (%)
Turning heating/cooling off to save money		
	Never or rarely	24 (7.5%)
	Sometimes	29 (9.0%)
	Often or always	105 (32.6%)
	Not an option in my dwelling	164 (50.9%)
Heating/cooling only one room of the house to save money		
	Never or rarely	25 (7.8%)
	Sometimes	20 (6.2%)
	Often or always	148 (46.0%)
	Not an option in my dwelling	129 (40.1%)

Indoor air quality data

Figure F2 shows the average daily outdoor and indoor temperature across all households participating in Valencia, starting in January 2023 (winter) and ending in July 2023 (summer). The increased average outdoor temperatures due to seasonal difference is also reflected in the average indoor household temperatures.

Figure F 2. Average daily indoor and outdoor temperature across all participating households in Valencia, including thresholds (min. 18 and max. 24 degrees Celsius)

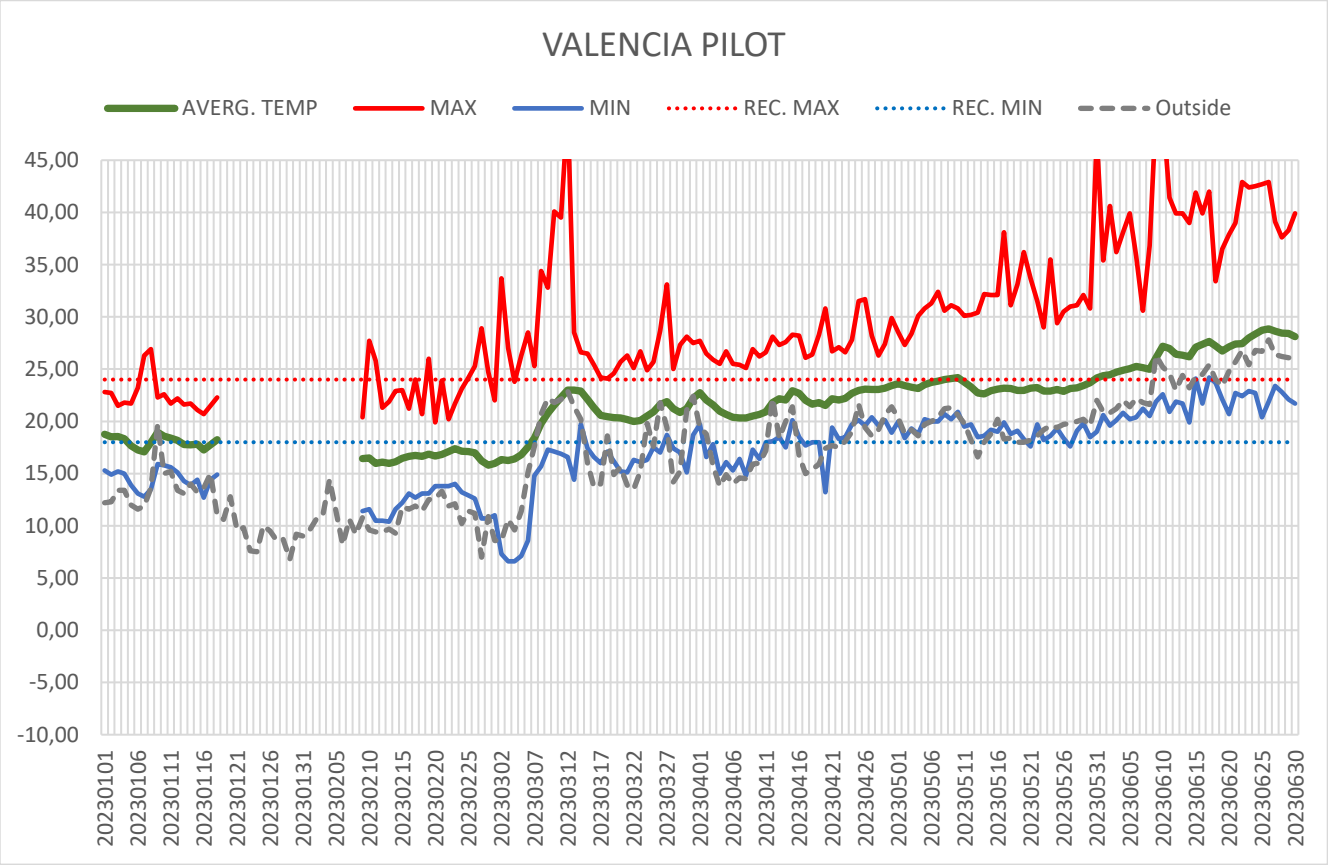


Figure F3 shows the percentage of time the temperatures were below or above the recommended threshold. During the winter period, the indoor temperature was mostly below the recommended threshold of 18 degrees Celsius. From June onwards, nearly 100% of the time the indoor temperatures were above the recommended threshold of 24 degrees Celsius.

Figure F 3. Percentage of time with temperature above the recommended 24 degrees Celsius and below the recommended 18 degrees Celsius in Valencia

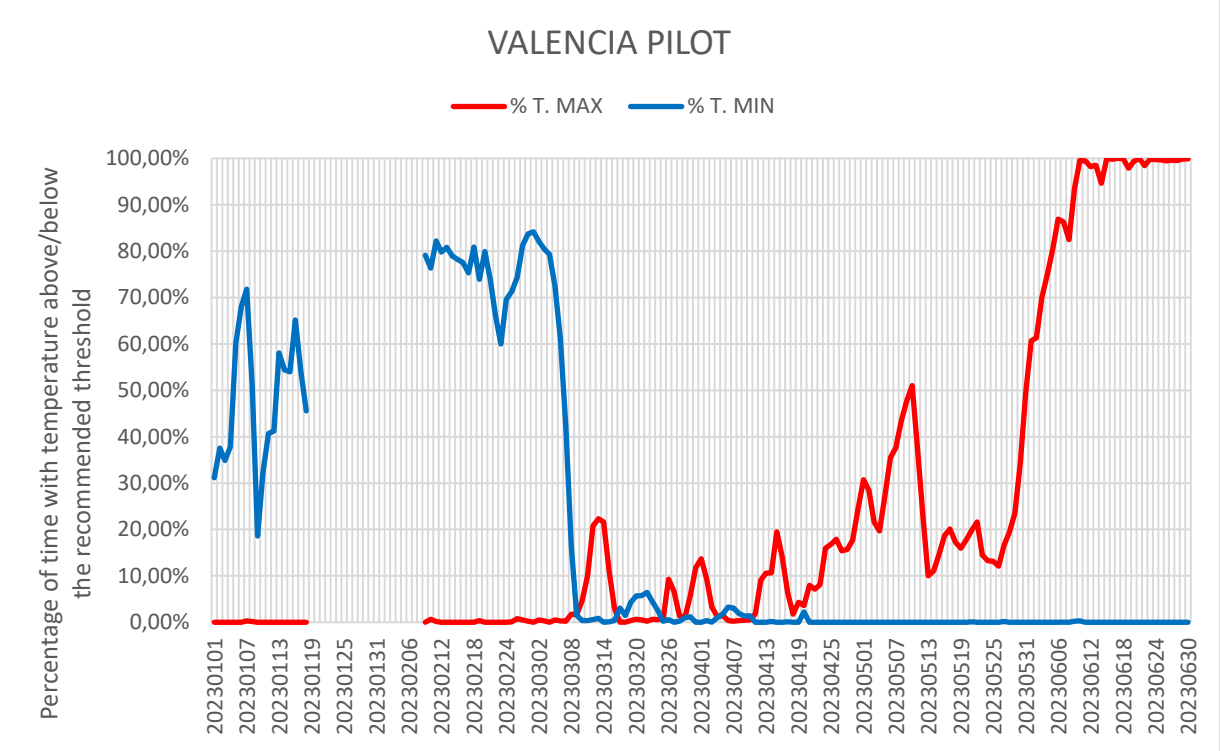


Figure F4 shows the average daily indoor humidity across all participating households in Valencia. It can be seen that the indoor humidity levels stay within the recommended thresholds while still mirroring the outdoor humidity levels trends, which occasionally exceeded the recommended threshold of 70%.

Figure F 4. Average daily indoor and outdoor humidity levels across households in Valencia including humidity thresholds (min 30%, max 70%)

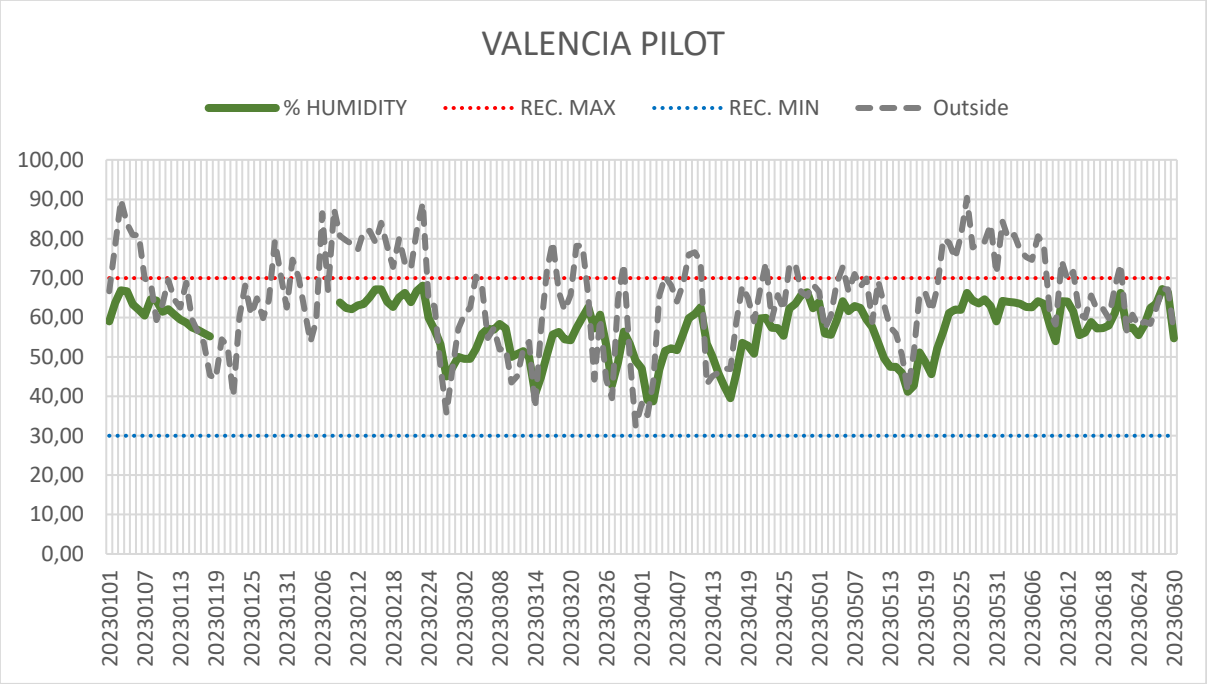
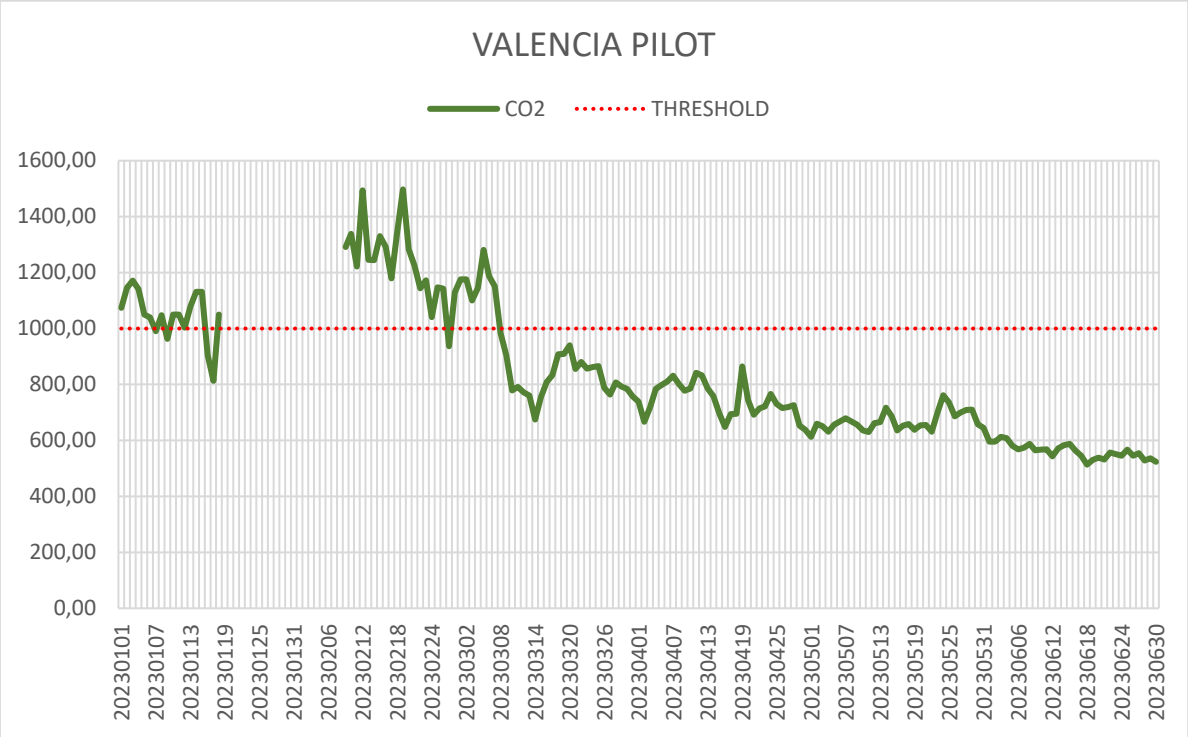


Figure F5 shows the average CO_2 levels in participating households in Valencia. It demonstrates a seasonal trend, with higher daily CO_2 levels in the winter (above the threshold) and lower levels in summer (staying below the threshold of 1000 ppm).

Figure F 5. Average daily CO_2 levels across households in Valencia including CO_2 threshold of max. 1000 ppm



Annex G: Frailty across pilot sites

Table G1 shows frailty values considered both as a continuous value with mean and standard deviation and also as categorical value (MPI 1-low, MPI 2-moderate and MPI 3-high risk) in each pilot site and in the total sample. Data shows that Edirne and Heerlen pilot cities have the highest mean and related categorical values (0.37± 0.17 and 0.36± 0.20 respectively). Data demonstrates that although Obuda is the oldest sample city (mean age=74.54), it is not the most frail, while Heerlen is not the oldest one (mean age=71.86), but it is the most frail.

Table G 1. 1 Demographic and multidimensional frailty

	Edirne (n=31)	**Heerlen (n=29)**	**Jelgava (n=49)**	**Leeds (n=17)**	**Obuda (n=48)**	**Valencia (n=36)**	**Total(n=210)**
Mean Age (±SD)	73.81(7.59)	71.86(6.57)	73.9(6.33)	70.53(4.21)	74.54(5.10)	74.19(6.20)	73.53(6.19)
Female (%)	19(61.29)	14(48.28)	39(79.59)	8(47.06)	42(87.50)	25 (69.44)	147 (70)
Mean MPI (±SD)	0,37(± 0,17)	0,36(± 0,20)	0,19(± 0,13)	0,31(± 0,21)	0,30(± 0,12)	0,30(± 0,19)	0,30(± 0,17)
MPI Category	2	2	1	1	1	1	1

Annex H: Sleep quality across pilot sites

Using the Pittsburgh sleep quality index (PSQI) the scores for sleep quality were calculated per pilot site (ES= Valencia, TR= Edirne, HU= Obuda, NL=Heerlen, LV=Jelgava, GB=Leeds), Figure H1-H7.

Figure H 1. Sleep duration (0 no difficulty – 3 severe difficulty)

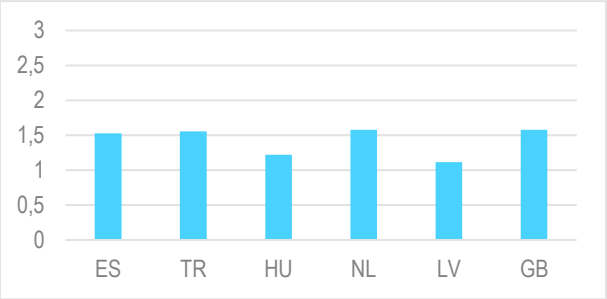


Figure H 2. Sleep disturbance (0 no difficulty – 3 severe difficulty)

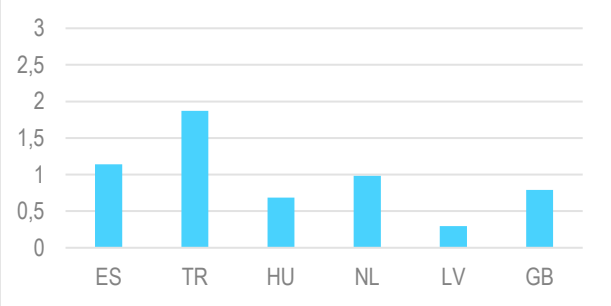


Figure H 3. Sleep latency (0 no difficulty – 3 severe difficulty)

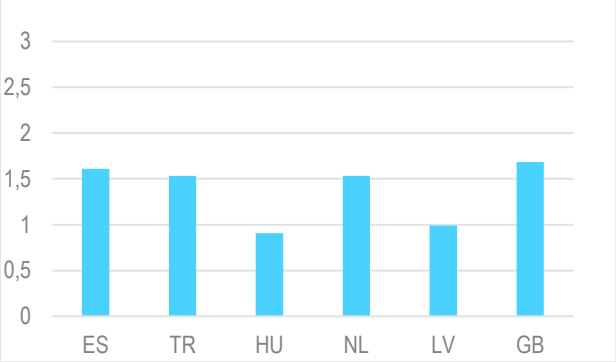


Figure H 4. Daytime dysfunction due to sleepiness (0 no difficulty – 3 severe difficulty)

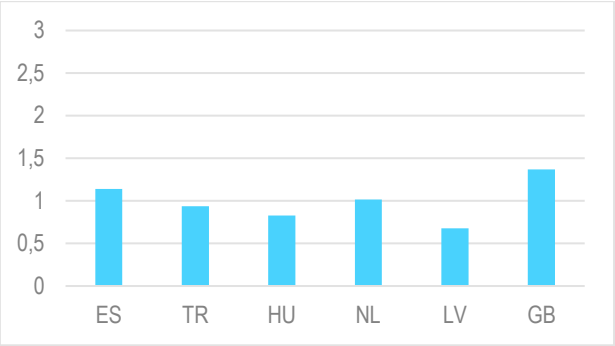


Figure H 5. Sleep efficiency (0 no difficulty – 3 severe difficulty)

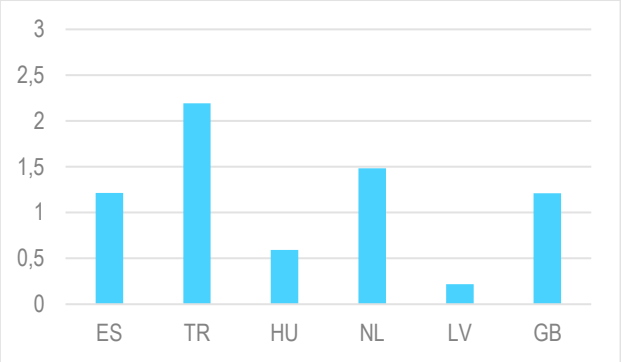


Figure H 6. Overall subjective sleep quality (0 no difficulty – 3 severe difficulty)

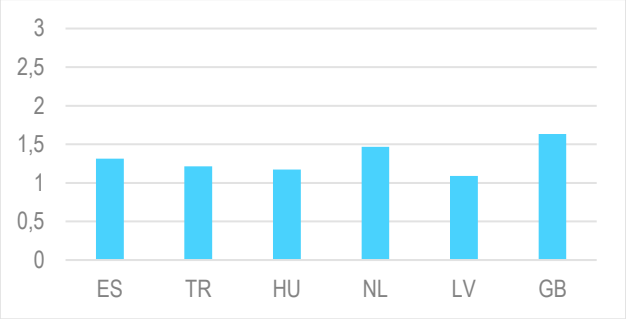
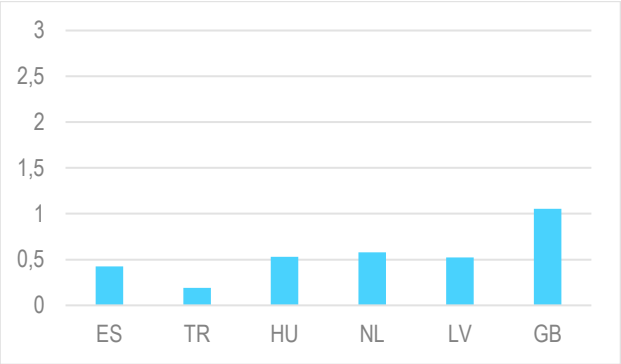


Figure H 7. Sleep medication use (0 no difficulty – 3 severe difficulty)



The figure H8 shows a view about the global quality of sleep in the six countries. The *X axis* numbered from 0 to 20 indicate the aggregated score of the quality, being the sum of the seven components that are included in the questionnaire. The *Y axis* numbered from 0 to 0.2 is the component In each x values. The highest the number the worse the quality of sleep.

Figure H 8. Overall representation of sleep quality in each pilot site