

THE SCALE OF ENERGY POVERTY AND ITS CONSEQUENCES IN A LARGE URBAN CENTRE – THE EXAMPLE OF THE CITY OF KRAKOW

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Purpose: The article aims to draw attention to energy poverty in Krakow and analyze its consequences.

Design/methodology/approach: The article is based on a questionnaire survey conducted in 411 households in Krakow.

Findings: 13% of households in Krakow experience energy poverty measured subjectively, based on declarations regarding the ability to heat their homes according to their needs, with 2% indicating that they can never afford to heat their homes to their preferred level. Most (almost 80% of households) of such households drastically reduce energy consumption at home, or (20% of households) leave the apartment for most of the day. As a result, these households report frequent colds and a lack of stability and security.

Research limitations/implications: The study was conducted in November 2022. Therefore, its results may reflect a particular issue that existed during a period after the outbreak of the war between Russia and Ukraine, amid the energy crisis. It should be noted that the changing macroeconomic and political situation in the country can heavily impact the material situation of households and, as a result, energy poverty. Additionally, the study focused on specific aspects of poverty without considering all its dimensions, and it was conducted based on subjective questionnaire responses without incorporating objective measures or direct measurements. Therefore, the article merely provides a glimpse into existing problems highlighted by the residents of Krakow rather than a comprehensive analysis of the phenomenon.

Originality/value: So far, no other studies have focused solely on the issue of energy poverty in Krakow. Such studies are rarely conducted in cities because this problem is often associated with rural areas. From the perspective of the authors of this work, this viewpoint is flawed because households living in apartment buildings also face difficulties in paying bills and thermal problems daily. Therefore, this study serves as a starting point for measuring the phenomenon's scale in cities and filling a gap in the extensive literature on energy poverty.

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Keywords: energy poverty, energy crisis, thermal issues, problem management.

Category of the paper: research paper.

1. Introduction

Energy poverty arises when energy expenses represent a significant portion of individuals' incomes, potentially hindering their capacity to meet other financial obligations. Additionally, energy poverty can manifest when individuals are compelled to curtail energy usage within their homes, ultimately impacting their physical and mental well-being (EPAH, 2024). Even before the outbreak of war in Ukraine, some studies were signaling an issue of energy poverty, indicating that addressing this challenge in Poland in the near future may prove difficult, with estimates indicating that between 22% to 33% of the population currently experiences energy poverty (Śmiech, Karpińska, 2021).

This study specifically examines one facet of energy poverty, focusing on the issue of insufficiently heated residences. The proportion of individuals unable to maintain sufficient warmth in their homes in Poland experienced a steady decline from 2009 to 2022, with a slight increase of 1.7 percentage points observed in comparison to the previous year (Eurostat, 2024). This recent rise can be attributed to the significant surge in energy costs triggered by Russia's invasion of Ukraine in February 2022. The research investigates the prevalence of unheated living spaces among Krakow residents and explores the repercussions of this discomfort on their daily lives. To date, there has been a lack of dedicated studies solely addressing the energy poverty situation in Krakow. The study material comprises surveys conducted among Krakow residents in November 2022.

The structure of this paper includes: (1) Introduction; (2) Review of literature on energy poverty; (3) Explanation of research methodologies; (4) Presentation of survey findings; (5) Discussion; (6) Conclusions.

2. Literature Review

The beginnings of broader interest among researchers in the issue of energy poverty occurred in the 1990s (Boardman, 1991). Currently, there are various definitions of energy poverty. Energy poverty can be defined as a lack of access to electricity (Ayodele et al., 2018) or when a household cannot adequately meet its energy needs (Bednar, Reames, 2020). A definition that accurately captures the nature of the phenomenon is the one provided by the Energy Poverty Advisory Hub, which indicates that Energy poverty occurs when energy bills constitute a high percentage of consumers' incomes, which can affect their ability to cover other expenses. Energy poverty may also occur when consumers are forced to limit energy consumption in their households, ultimately impacting their physical and mental health and well-being. Additionally, low household incomes, inefficient buildings and appliances,

and specific energy needs of households contribute to this challenge (EPAH, 2024). Therefore, according to the above definition, the three main determinants of energy poverty can be identified as: a) low incomes, b) high energy expenditures, and c) energy-inefficient buildings.

There are various approaches to measuring energy poverty (Palma, Gouveia, 2022; Rademaekers et al., 2016; Mamica et al., 2021). For instance, there are expenditure-based approaches where national energy expenditures are compared with incomes. If costs exceed a certain threshold of energy poverty, the household is identified as energy poor. Another measurement method is consensus-based, where residents report their own experiences and assessments regarding thermal comfort or other housing conditions in their homes and their ability to finance and guarantee essential energy services. Energy poverty can also be measured based on outcomes, with health issues commonly considered in this approach. Additionally, the issue can be measured through direct measurements, where household energy consumption is compared, verifying if, for example, the household maintains a comfortable temperature. In this aspect, certain studies have an objective character (e.g., the LIHC method - Low-Income High Costs). In contrast, others have a subjective nature, such as considering household declarations indicating that they do not meet their energy needs and live in excessively cold homes (Lis et al., 2016a). Quantitative, multidimensional approaches have been developed to measure the phenomenon discussed in this work (Castaño-Rosa et al., 2020; Gouveia et al., 2019; Alba-Rodríguez et al., 2021). These works utilise various available indicators related to the three main determinants of energy poverty. On the other hand, in other words, survey research has been utilised to collect data, which is then used to conduct statistical analyses where indicators are standardised and weighted. (Boemi, Papadopoulos, 2019; Boemi et al., 2017; Sokołowski et al., 2020).

It should be emphasised that diagnosing the scale of the energy poverty phenomenon is limited due to the lack of a unified methodological concept. For example, in 2015, a study was conducted on the level of poverty in Spain (Romero et al., 2018), Using three different indicators: a) 10% (a home would be energy poor if its expenditure on energy services exceeded 10% of its total income), b) LIHC (household is defined as energy poor when income is below a specific (relative) poverty threshold and when its energy costs are higher than an energy expenditure threshold), c) MIS (household would be energy poor if it does not have enough income to pay for its basic energy costs, after covering housing and other needs), this analysis showed that the level of poverty varied between 8.10% and 14.96% depending on the chosen indicator. Moreover, 3% of Spanish households were found to be energy-poor according to these three indicators. These three indicators identify different households, indicating they do not measure the same problem (Romero et al., 2018). To measure energy poverty, the AFCP (After Fuel Cost Poverty) indicator is also utilised, where energy poverty is characterised as the condition in which a household's net income (after subtracting energy and housing expenses) falls below 60% of the median net income of all households (after subtracting energy and housing expenses). Additionally, the double median expenditures 2M indicator is used, where

households in a state of energy poverty are those whose energy spending equals or exceeds twice the median proportion of household energy spending (Mendoza Aguilar et al., 2019). Multidimensional indexes are also utilised, such as the one applied to Polish conditions, which uses five dimensions of energy deprivation: two objective indicators of "low income, high costs" and "high actual cost", as well as three subjective indicators of "not warm enough home", "housing faults," and "bills difficulties" (Sokołowski et al., 2020). In this convention, the Multidimensional Energy Poverty Index (MEPI) has also been proposed, considering both the intensity and occurrence of energy poverty. It is a new tool to support policymaking in this area (Nussbaumer et al., 2012). In the analysis conducted by Siksnyte-Butkiene et al. (2021) seventy-one different methods of measuring energy poverty have been diagnosed, wherein the 10% method was utilised 25 times, 2M method five times, MIS method three times, LIHC method 15 times, AFCP method five times, EU-SILC method (difficulties in maintaining adequate temperature in the home) 11 times, EU-SILC method (leaking roof, damp walls, rot in window frames) 6 times, EU-SILC method (inability to pay bills on time) 8 times, and other measures or questionnaires in various combinations.

Energy poverty is a topic addressed in many countries, with a particularly significant amount of work found in Greece (Papada et al., 2016; Papada, Kaliampakos, 2017, 2018, 2019; Boemi et al., 2017), in Spain (Mendoza Aguilar et al., 2019; Martín-Consuegra et al., 2020; Alba-Rodríguez et al., 2021), also in Portugal (Gouveia et al., 2018; Horta et al., 2019; Oliveira Panão, 2021). So far, Poland has conducted a number of studies on energy poverty. A significant portion of the work has been carried out by the Institute for Structural Research (Lis et al., 2016b; Szpor, Lis, 2016; Lis et al., 2016c; Lis et al., 2016a; Sokołowski et al., 2020).

In turn, we can consider the most recent research to be analyses conducted by (Karpinska, Śmiech, 2021b), who investigate the impact of changing energy sources on the extent and depth of energy poverty in Poland. In another study, the same authors examined the profiles of energy-poor households and the determinants enabling them to escape energy poverty, considering long-term interactions between energy poverty and poverty (Karpinska, Śmiech, 2021a).

The issue of energy poverty in Poland is often associated with air pollution problems, as evidenced by studies on the role of smog alerts in addressing air pollution and energy poverty issues (Frankowski, 2020). Energy poverty in Poland is generally associated with the phenomenon of low emissions and smog, which is because individuals affected by energy poverty more often use low-quality solid fuels for heating (Śmiech, Karpińska, 2021; Dzikuć et al., 2021; Karpinska, 2021; Król, Gomola, 2022). The research results indicate a relationship between respondents' poor material situation and their attachment to traditional energy sources, such as coal (Żuk et al., 2021). Some studies highlight political issues, such as presenting the thesis that the lack of political and institutional recognition is at the core of reproducing national energy poverty in Poland (Simcock et al., 2021).

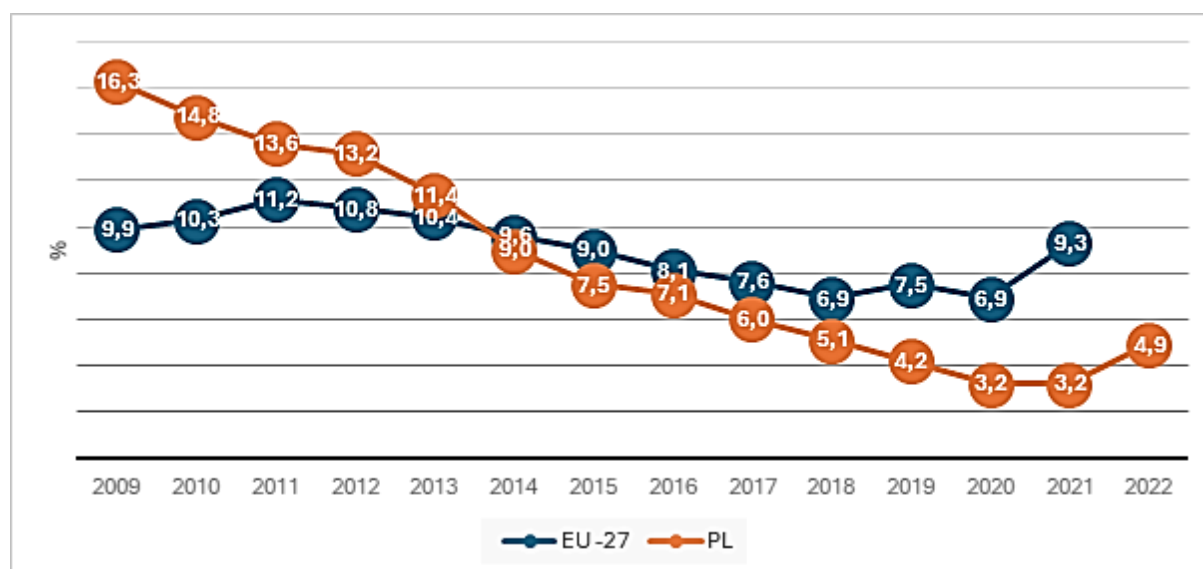


Figure 1. Average percentage of population unable to keep home adequately warm for EU 27 and Poland.

Source: own study, based on (Eurostat 2024).

The percentage of the population unable to keep their homes adequately warm in Poland had a consistent downward trend from 2009 until 2021, when there was an increase compared to the previous year by 1.7 percentage points (Figure 1). The recent growth can be attributed to the sharp rise in energy prices caused by Russia's invasion of Ukraine in February 2022.

While 2009 this indicator stood at 16.3%, by 2021 it had decreased to only 3.2%. The situation has also been improving compared to the average for the 27 EU countries. While in 2009, the latter was lower than the Polish average by over six percentage points, since 2015, the situation in Poland regarding the ability to heat homes has been better than the EU average. In 2021, in Poland, nearly three times fewer people could not heat their homes compared to the EU average.

Currently, undertaking an analysis of the issue of poverty becomes particularly significant because rising energy prices exacerbate the problem of energy poverty (Karpinska, Śmiech, 2022). Additionally, current estimates indicate that energy poverty resulting from the pandemic will not be overcome until 2025 (Carfora et al., 2022). Additionally, it is worth noting that we are currently still grappling with an energy crisis exacerbated by Russia's invasion of Ukraine. The shock caused by the war may have tangible effects on many households worldwide, contributing to the exacerbation of the discussed phenomenon. Research on this topic seems to be extremely important because the goal of reducing energy poverty and achieving a just transition is only visible in strategies after 2014 (Rabiej-Sienicka et al., 2022). Indeed, the period in which actions were taken in this direction in Poland is relatively short. Additionally, current research indicates that it will be difficult to solve this problem in Poland in the near future, and currently, energy poverty affects from 22 up to even 33% of people (Śmiech, Karpińska, 2021).

This work focused on a specific dimension of energy poverty, namely the aspect of underheated homes. The study examined how many residents of Krakow declare that they are sitting in unheated apartments and how this discomfort affects the lives of these individuals.

3. Research Methodology

The research material consists of surveys conducted among residents of Krakow in November 2022. The study considers the diverse structure of buildings in the city, including residents of residential blocks, encompassing both panel buildings and modern multi-family buildings, as well as old tenement houses in the historic centre of Krakow. The study involved 442 households; however, due to incomplete responses or highly incorrect declarations, data were cleansed from those that disrupted the study. Therefore, the sample included 411 families using district heating, individual central heating gas installations, or electric storage heaters commonly found in tenement houses in the old part of Krakow. The study was conducted using CATI and CAWI methods. The aim of the study was operationalized into three research questions, which also determined its focus, namely:

1. What is the scale of the problem of underheated homes in Krakow?
2. Is the level of energy poverty differentiated by the type of building in which the apartment is located?
3. What do residents do when they cannot heat their home/apartment adequately according to their needs?
4. What are the consequences of living in an underheated home?

A survey was utilized to answer these questions, containing 22 questions (including metric questions). However, for this study, only six questions related to thermal problems, coping strategies, and their consequences were used. The article adopts a description of issues perceived from the residents' perspective, thus relying on a subjective approach. Quantitative questions such as income levels or expenditures on energy purposes were omitted in this study.

Table 1.

Characteristics of the questionnaire items included in the analysis and the number of responses obtained

The researched issue	Question category	Respondents' answers	Number of responses given
Feelings of residents towards the upcoming heating season	Obligatory	<ul style="list-style-type: none"> • Concern about high heating bills • Concern about high electricity bills • Fear or lack of access to energy sources • No worries 	411
Possibility to heat the apartment according to your own needs	Obligatory	<ul style="list-style-type: none"> • Yes, always • Yes, mostly • Usually not • No, never 	411

Cont. table 1.

Ways of dealing with heat problems	Additional (for individuals declaring an issue regarding question no. 2)	<ul style="list-style-type: none"> • We are significantly lowering the temperature in the house • We leave the house for most of the day • We take out loans to pay the bills • We ask our family/friends for help • We are not managing 	55
Experiencing health problems as a result of insufficient heating of the apartment in recent years	Obligatory	<ul style="list-style-type: none"> • Yes, serious issues • Yes, but to a limited extent • No 	411
Types of health problems	Additional (for individuals declaring an issue regarding question no. 4)	<ul style="list-style-type: none"> • Frequent colds • Exacerbations of chronic diseases (asthma) • Depressive states • Others 	75
Impact of energy problems on household members	Additional (for individuals declaring an issue regarding question no. 4)	<ul style="list-style-type: none"> • Deterioration of family relationships • Educational problems of children • Professional problems • Lack of stability and security • Others 	75

Source: own study.

4. Results

The significance of the discussed issue at the investigated point in time is underscored by the fact that 63% of the survey respondents in this study declared concerns about high heating bills in November 2022 (i.e., the beginning of the heating season). Following closely, 59% of individuals were worried about high energy bills. Notably, almost as many people expressed concerns about high heating bills as about energy bills. One in five respondents indicated concerns about the lack of access to resources. It is worth noting that during that period, there was a coal shortage in storage yards (Bijańska, Wodarski, 2024). Only 17% of individuals declared having no concerns, indicating that the energy crisis impacted not only the most impoverished individuals but also caused uncertainty among those significantly better off.

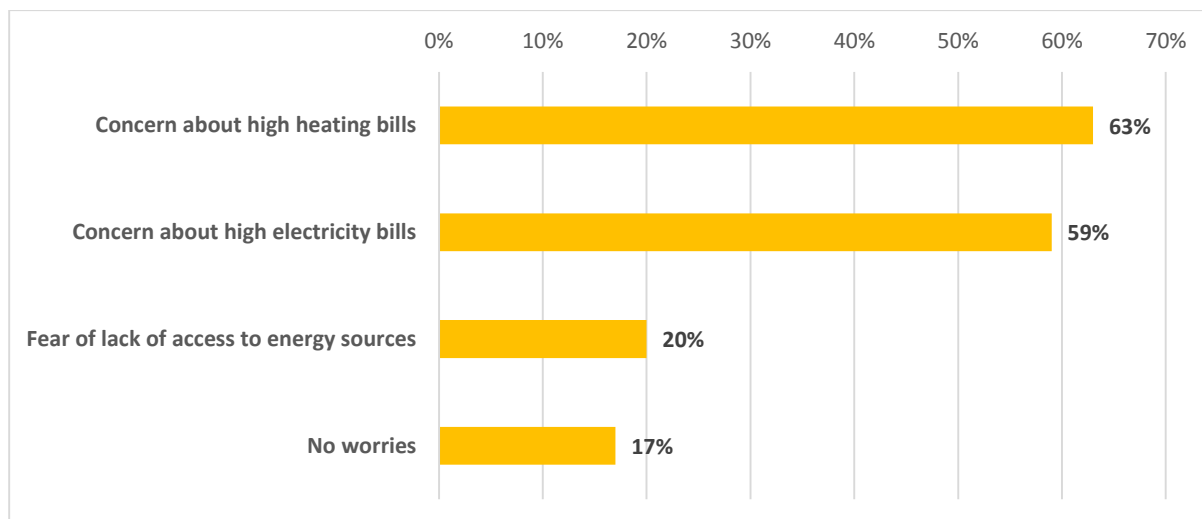


Figure 2. Feelings of residents towards the upcoming heating season (22/23) (n = 411, multiple choice).

Source: own study.

Respondents to the survey answered a question about their ability to heat their flats according to their needs (Figure 3). EU-SILC carries out a similar survey and the results are made available in the Eurostat database and are presented in this work for the whole of Poland (Figure 1). It is worth noting that 36% of people declared that they are always able to heat their dwelling according to their needs, and 51% said that they can do so most of the time. Most importantly, 13% of people experience a perceived inability to meet their heating needs, with 11% of people declaring that they are usually unable to heat their dwelling and 2% indicating that they can never afford to provide heating comfort, which to some extent provides a good indication of the scale of fuel poverty and extreme fuel poverty in Kraków at the time of the study.

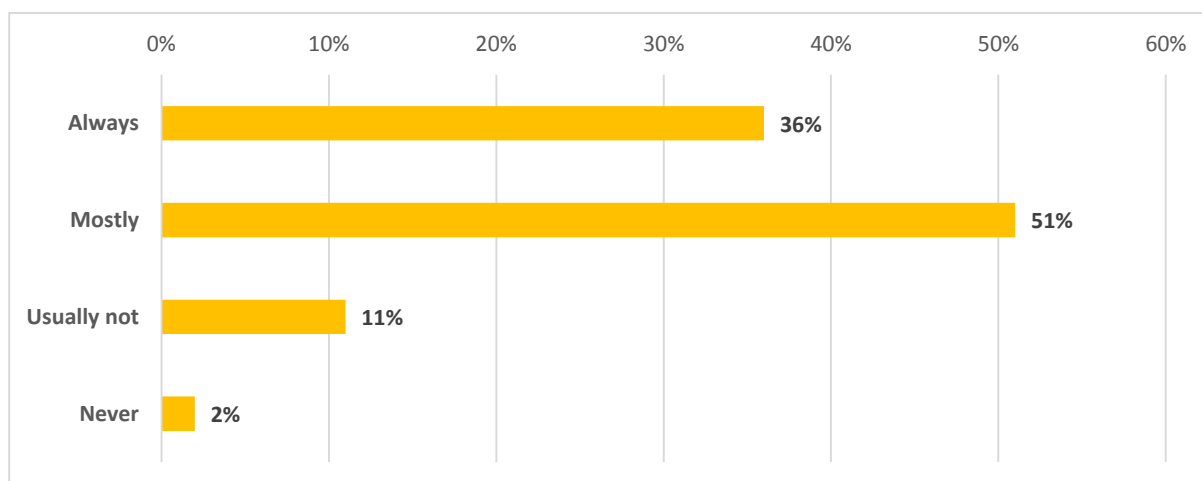


Figure 3. The ability to heat the apartment according to needs (n = 411, multiple choice).

Source: own study.

The lowest percentage of people who are always able to heat their apartments pertains to owners of single-family homes (about 10%), with residents of apartment blocks most frequently indicating this option (around 40%). In the case of tenement residents, it was 27% of them. An analysis of the data from Table 2 indicates an apparent problem with heating apartments among tenement residents. Over 16% of them declare that they are usually unable to heat them, and over 8% say they can never heat them to the desired temperature. In the case of single-family homes, the percentage of people who can never heat them is only slightly over 3%, and in the case of apartment block residents, just somewhat less than one percent. The problem with heating apartments in tenements is related to minimal limited possibilities for external thermal modernisation due to conservation requirements. At the same time, they are often very high apartments and difficult to heat.

Table 2.

The ability to heat an apartment depending on its type (n = 411)

The ability to heat an apartment	Apartment in a block	Single-family house	Apartment in a tenement
Always	40,1%	10,3%	27,0%
Mostly	48,8%	69,0%	48,6%
Usually not	10,2%	17,2%	16,2%
Never	0,9%	3,4%	8,1%

Source: own study.

Out of the entire research sample, 55 individuals (11+2%) indicated that they were unable to ensure their thermal comfort (Figure 3). Further inquiries yielded exciting findings, revealing that 78% of respondents opt to lower the temperature in their living spaces significantly (Figure 4). This is by far the most commonly reported response. Hence, the attempt to reduce bills expenses is evidently visible here, indicating an issue with energy poverty. One in five respondents suggests that they spend most of their time away from home, slightly more frequently than 1 in 10 energy-poor individuals seek financial support from family or friends. The least commonly cited response is resorting to loans, indicated by 9% of individuals, vividly demonstrating that people in difficult financial situations prefer enduring cold homes over getting into debt. This may suggest a lack of prospects for improving their economic situation in the future. Notably, 5% of individuals declared that they struggle entirely with the current situation.

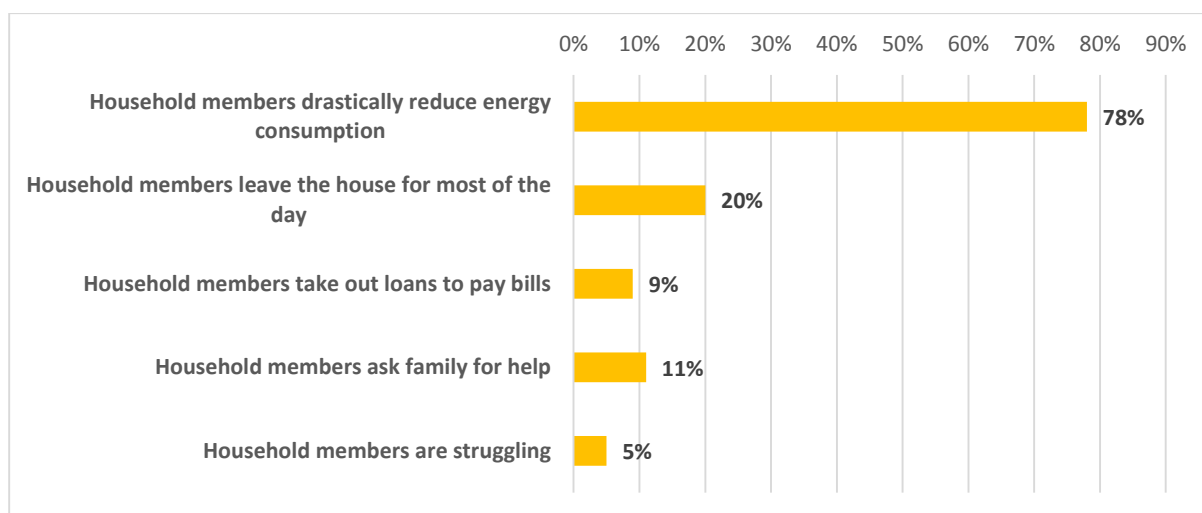


Figure 4. Ways of dealing with heat problems (n = 55).

Source: own study.

Respondents were also asked about experiencing health problems due to insufficient heating in their apartments. It was decided that this question would be asked to everyone and would serve as a control function to verify whether the response structure corresponds to the question regarding the ability to heat the apartment according to needs. As analysis of Figure 3 shows, approximately 13% of respondents are unable to heat their apartments according to their needs. In contrast, analysis of data from Figure 5 indicates that 18% experience health problems due to inadequate heating. This discrepancy may stem from the fact that 51% of individuals indicated that they can usually afford to heat their apartment (Figure 3), which does not rule out the possibility that occasional situations requiring temperature reduction may have implications for health problems; similarly, we cannot be sure that individuals who are clearly energy poor but spend the majority of their time away from home will experience the consequences of inadequate heating.

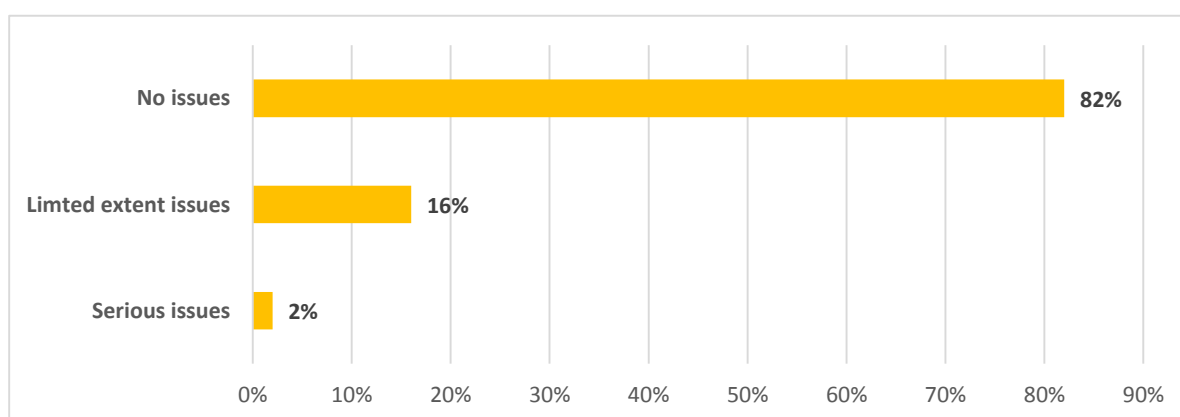


Figure 5. Experiencing health problems as a result of insufficient heating of the apartment in recent years (n = 411).

Source: own study.

The key conclusion drawn from this part of the study is that while 18% declare experiencing health problems, only 16% do so to a limited extent and only 2% to a severe extent, which underscores the fact that most often, individuals who report experiencing problems tend to mention the occurrence of frequent colds (Figure 6). Approximately a quarter of the respondents note the occurrence of asthma problems and depressive symptoms. Only 2% indicate serious issues, which again may suggest that 2% of individuals living in Krakow are extremely energy-poor.

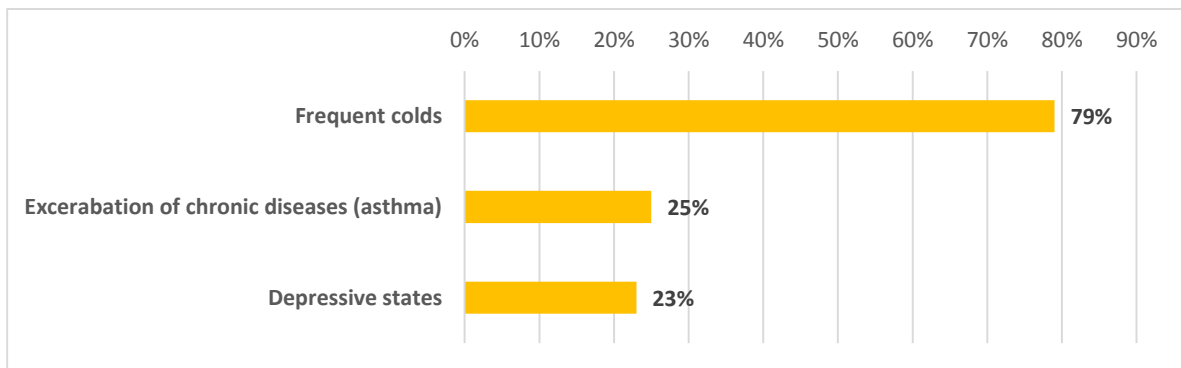


Figure 6. Types of declared health problems (n = 75).

Source: own study.

Figure 7 shows that exactly 65% of the respondents indicated a lack of stability and security, 32% mentioned work-related issues, 24% noted a deterioration in family relationships, and 13% mentioned educational problems with their children. Additionally, 5% of individuals declared the presence of other issues; however, these were not elaborated upon in detail.

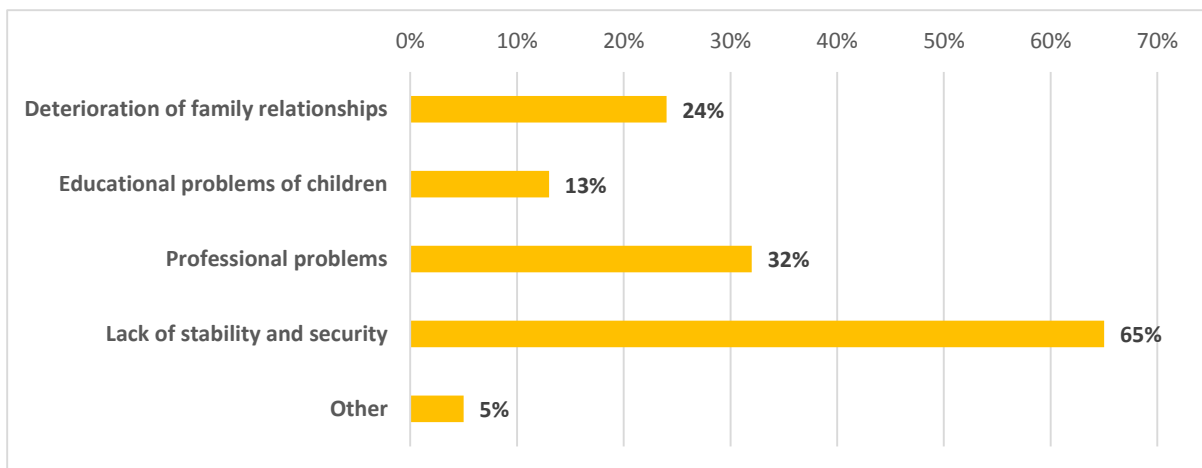


Figure 7. Impact of energy problems on household members (n = 75).

Source: own study.

5. Discussion

The results of the conducted research indicate the existence of a link between energy poverty and health problems, which is consistent with the findings of international studies conducted on a group of 175 countries, which unambiguously confirmed that energy poverty has a detrimental effect on public health (Pan et al., 2021). Similar conclusions arise from research conducted in two Polish cities such as Ruda Śląska and Tychy, which showed that living in substandard housing conditions (mould, leaking roof) is related to a higher risk of developing musculoskeletal and cardiovascular diseases (Sokołowski et al., 2020). Previous studies conducted in Mexico and the United Kingdom also indicated that energy poverty has a powerful detrimental effect on health (Harrington et al., 2005; Ochoa, Graizbord, 2016). The research also includes the connection between indoor temperatures and excess winter mortality (Sakka et al., 2012).

The consequences of energy poverty can also include a negative impact on health due to stress associated with the inability to pay energy bills (Liddell, Morris, 2010). In our study, this can be linked to the problem of depressive states, indicated by 23% of respondents who declared health problems related to energy poverty. Concern about the ability to pay energy bills is visible in our research, where as many as 63% of respondents indicated concerns about their ability to pay them. Actions in the field of domestic energy efficiency investments in low-income areas translate into improving the health status of residents benefiting from these actions (Grey et al., 2017). Therefore, it is crucial to take action regarding the thermal modernisation of the existing housing stock in Poland. This will provide the basis not only for reducing energy usage costs, thus reducing the level of energy poverty, but will also have a tangible positive impact on greenhouse gas emissions and suspended particulate matter. Despite the increasing energy literacy in Poland (Białynicki-Birula et al., 2022; Szczygieł, Śliwa, 2023), energy poverty remains a barrier to transitioning to less emissions-intensive, yet often more expensive, heating sources. The monthly updated cost calculator for heating homes in Polish conditions (<https://oape.uek.krakow.pl/>) clearly shows that electric heating remains the most expensive form. However, it is worth noting the relatively higher costs associated with coal heating in stoves compared to natural gas. This leads to a situation where reducing energy poverty may be related to a simultaneous reduction in emissions of suspended particulates emitted during coal combustion.

Although in Polish conditions, energy poverty is primarily analysed from the perspective of insufficient heating of premises due to the climate type, the inability to adequately cool apartments also hurts health. Studies on the effects of such energy poverty on health, for example in Australia, have shown that a standard deviation increase in energy poverty is associated with a decline in general health between 0.099 and 0.296 standard deviations (Awaworyi Churchill, Smyth, 2021). The observed negative impact of fuel poverty on

subjective well-being in the presented studies is also confirmed by similar research in this area (Biermann, 2016). For example, in Australia, a standard deviation increase in fuel poverty is associated with declines of 0.168–0.458 standard deviations in subjective well-being (Awaworyi Churchill et al., 2020).

6. Conclusions

The most important findings from the study, organised by research question, are presented below:

1. Regarding the issue of energy poverty resulting from the inability to heat the apartment according to their needs, 13% of respondents indicated this problem, 11% stating that they have issues with this "usually", and 2% are never able to heat their apartment. On the other hand, 36% of Krakow residents declared that they can always heat their apartment according to their needs, and 51% can do it most of the time. Particularly significant seems to be the latter value, which shows that nearly half of households during the study period could not feel complete thermal comfort, suggesting that many households are sensitive to the country's macroeconomic situation, and its deterioration could lead to grander greater energy poverty.
2. Particularly vulnerable to energy poverty in Krakow are residents of tenement houses, where total inability to heat apartments was noted over nine times more frequently (8.1%) compared to residents of apartment blocks (0.9%) and over twice as often compared to residents of single-family houses, where 3.4% of respondents were unable to heat them.
3. Of the 13% of energy-poor households, almost 4 out of 5 declare that they significantly lower the temperature at home, while 1 out of 5 leave home for most of the day. Borrowing money from a bank or friends is not the preferred way of dealing with this problem, which may suggest that households are afraid to incur debt for energy purposes.
4. Less than 20% of all respondents declare that they experience health problems due to the inability to heat the apartment, with the vast majority declaring that these are minor problems (primarily frequent colds). Nevertheless, about 1 in 4 households also declare issues with asthma and the occurrence of depressive states. It is also worth noting that frequent colds can result in absenteeism from work (which results in temporarily lower income and certainly does not improve the financial situation of an energy-poor household), as well as affect the absenteeism.

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