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Determinants of the Energy Poverty of Polish Students during the COVID-19 Pandemic

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Abstract: The aim of this paper is to define the factors influencing the level of energy poverty among students. The analysis of these factors is based on the results of a survey conducted among a group of 937 students at the Cracow University of Economics. The study takes into consideration the changes in the attitudes and behavior of students resulting from the introduction of distance learning during the COVID-19 pandemic. The switch to distance learning resulted in a significant increase in the number of responses related to feeling ill or sick due to inadequate temperature (from 24% before a lockdown to 32% after the introduction of a lockdown). Students experienced temporary surges in their overall living costs due to the pandemic, especially during the first wave. The respondents who experienced inappropriate temperatures (inadequate heating) due to excessive costs felt ill or became sick more often than others. The study demonstrated that those who pay more for energy (defined as a surplus payment in excess of 10%) tended to be, on average, less energy-aware than others. The following indicators of energy poverty among the students were distinguished: high living costs, small degree of influence over the choice of living quarters, as well as concerns over energy efficiency and environment. The conclusions drawn from the conducted studies may be utilized to design public policies aimed at curtailing the phenomenon of energy poverty among students. This issue is particularly prominent in large urban agglomerations where the costs of living are high and result in the feeling of pressure regarding the need to save money on thermal energy consumption.

Keywords: energy poverty; COVID-19; student; energy consumption

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1. Introduction

The latest studies in the field of energy poverty among students realized on a research sample of more than 3500 students in 7 different European countries [1] indicate that students are an under-reported and under-supported group of the wider population and they frequently live in energy poverty. Furthermore, students are frequently unaware that they are living in energy poverty and about the fact that they are a group exposed to this phenomenon [2]. Energy poverty may also be a major factor in determining the educational success of students. Studies regarding the relationship between access to electricity and education in India [3] clearly demonstrated that the students whose households are electrified are more competitive and successful in examinations than their counterparts whose households are not electrified.

In Poland, just as in the Czech Republic [4], policy aimed at tackling the issue of energy poverty is still at the initial stage of developing a cohesive set of actions. The fact that the number of people declaring that they are unable to keep their home adequately warm has been decreasing for more than a decade does not justify the current state of the anti energy poverty policy [5]. The need to introduce policy aimed at reducing energy poverty concerns the entire region because, according to estimates, on average over 23% of the Central and Eastern European population is exposed to hidden energy poverty [6]. The COVID-19

pandemic brought about fundamental changes in the functioning of universities, as well as the professional and housing situation of students. The research results presented in this paper are based on, among other things, the comparative analysis of the opinions of students from before and after the introduction of distance learning, which enabled us to define the observable consequences of lockdown regarding energy poverty.

1.1. Definition, Measurement and Determinants of Energy Poverty

Approaches to energy poverty depend on how it is measured [7] given the fact that there is no single, universally accepted definition of this concept [8,9]. In developing countries, energy poverty tends to be perceived in terms of access to more sophisticated sources of energy than the burning of solid fuels by households [10,11]. Conversely, in highly developed countries, energy poverty is characterized in terms of economic affordability [12,13]. Other approaches, such as the Perception-based Multidimensional Energy Poverty Index (PMEPI) proposed by Villalobos et al. [14], go beyond the monetary poverty identification outcome. The concept of energy poverty can also be indirectly linked to the implementation of the 2030 Agenda for Sustainable Development [15], which, under Target 7.1, aims to ensure access to affordable, reliable, and modern energy services. In our study, we adopted the most commonly accepted definition, namely the one proposed by Boardman [16], which states that the energy poverty occurs when fuel costs borne in order to maintain satisfactory heating conditions are higher than 10% of income. According to the Warm Homes and Energy Conservation Act 2000 "a person is to be regarded as living 'in fuel poverty' if he is a member of a household living on a lower income in a home which cannot be kept warm at reasonable cost" [17]. A different approach to defining energy poverty is based on the capability to ensure and maintain a minimum temperature of 18 °C inside a house in winter [18]. However, recommended minimum temperatures may differ in various countries. For instance, in Scotland an additional distinction regarding the age of residents and the part of the house has been made: the temperature in the living room of the elderly (60+) should be maintained at 23 °C and at 18 °C elsewhere for 16 h a day [19]. In England, in the case of people at work or in full-time education, the number of hours during which a minimum temperature is to be maintained is limited to 9 h a day [20]. However, the remote work and distance learning imposed by the Covid-19 pandemic restrictions resulted in extending the time spent inside homes and apartments to nearly 24 h a day and therefore resulted in additional increases in heating costs. The reduction of household income accompanying this phenomenon resulted in the increased threat of such households being affected by energy poverty. In countries where higher temperatures are recorded in the summer season, energy poverty may also affect the indoor overheating problem, as confirmed by studies conducted in such countries as Portugal [21] or Greece [22].

An attempt to define energy poverty in a manner different than solely by the percentage of expenditure devoted to heating was made by proposing the Low Income and High Costs (LIHC) indicator, according to which the energy poor are "those people who have both a lower income, that is they fall below an income threshold, and required costs above a 'reasonable level'" [23]. We should not only consider the level of income at the disposal of a given household, but also the costs of purchasing energy. The latter may be differentiated by e.g., the use of time-of-use (TOU) pricing systems, which allow for the purchase of cheaper energy during periods outside of the peak energy consumption hours. However, doing so requires converting to this form of settling payments, which is more frequent in the case of households of a smaller size or with a greater number of smart technologies being utilized in the house [24]. Thus, the costs of heating buildings insulated in exactly the same manner may differ according to the adopted energy schedule. However, the term energy poverty is subject to a variety of determinants exceeding technical and organizational aspects, also encompassing the socio-economic status of the residents [25]. The studies conducted by Bennett et al. [26] concerning energy poverty demonstrated that this phenomenon is also a function of variables such as income, state benefits, and gas

payment methods. Apart from the aforementioned objective measures, subjective measures are also utilized to measure energy poverty, related to the sense of being able to ensure proper heating in a place of living. The analysis of both approaches to taking measurements demonstrated that they were positively related in a complex way [27]. Dynamic models taking into account the differences in temperature across time and space and in energy prices are also used to measure energy poverty [28].

1.2. Energy Awareness and Energy Poverty

Studies conducted in India demonstrated that in households belonging to low- and very-low-income groups, awareness plays a positive role in undertaking actions aimed at conserving energy and, as a consequence, leads to the lowering of electricity bills [29]. However, in the more affluent households covered by the aforementioned studies, despite their high awareness, the actions in the field of energy conservation are not considered as significant, which may result from the fact that residents of such households do not deem taking such actions to be necessary due to their material status. Research on the relationship between energy poverty and other factors was conducted in 81 provinces of the Philippines and displayed that from among seven indicators, problems with access to communication and education were the factors most frequently associated with energy poverty [30]. The negative impact of energy poverty on household average school years was recorded in the case of Laos [31]. Energy poverty, particularly in the form of a lack of access to the power grid, requires devoting a significantly higher amount of time to collecting the necessary fuel (firewood) and negatively influences the situation of women to a greater degree, whose role is traditionally more frequently associated with preparing meals.

1.3. The Social Influence of the COVID-19 Pandemic

As demonstrated by the studies conducted by Jung et al. [32], the job insecurity caused by the COVID-19 pandemic induces lower job engagement. Apart from the decreasing demand for numerous goods and services, companies are additionally struggling with the problem of lowered engagement amongst employees—all these factors together result in decreased revenues and the resulting lowering of salaries. For this reason, the group of people threatened with energy poverty is expanding. A sharp drop in demand in sectors of industry such as tourism or lodging caused by the pandemic [33] adversely influences the income of students employed part-time in these sectors. Conversion to distance learning results in the need to provide heating throughout the entire day, whereas students were previously able to reduce the temperature at homes and thus reduce heating costs when they were away studying. It is estimated that over 84% of the total number of enrolled learners (nearly 1.7 billion students) experienced the temporary closure of schools in April 2020 due to the pandemic [34]. Research conducted in the USA showed that two weeks after students returned home due to the closing of universities, a peak in COVID-19 cases was observed [35]. Thus, it can be assumed that a part of the student population was infected at campus and going through the illness, including asymptomatically, became a source of infection after returning home. The need to undergo quarantine resulted in lowered professional activity of family members and, in conjunction with potential costs of treatment, may have influenced and reduced the disposable income available and increased the threat of energy poverty. The effects of introducing the so called Shelter-in-Place Orders (SIPOs) became the object of study in the case of e.g., restaurant, entertainment, and school closures due to the fear of the pandemic spreading [36]. However, not all studies unambiguously indicate the explicit effects in this field resulting from the closure of public schools [37]. Problems with the adequate heating of apartments may result in the further growth of the group of students, already enhanced due to forced distance learning, who are at risk of falling into depression. In Ecuador, the country with the highest percentage of people suffering from depression, this affects an estimated 1 in 6 students [38].

Apart from the obvious economic consequences, the COVID-19 pandemic produced a number of effects which affect society in general as well as individuals. One such

effect is the aforementioned mental health consequences. A significant number of existing studies [39–41] confirm that the pandemic and the related preventative measures such as quarantine, social distancing, and self-isolation may have an adverse effect on mental soundness. Another consequence of the COVID-19 pandemic is the human mobility restrictions. The studies conducted by Bonaccorsi et al. [42] indicate that restrictions of this type reduce the fiscal revenue on the central and local levels and result in the growing poverty and social disparities, if proper actions are not taken by public authorities. At such times the pressure for limiting certain social expenditures, typical for the periods of crisis, arises [43]. Additionally, under lockdown conditions, the vulnerability to the risk of domestic violence aimed at women and children increases [44].

1.4. Health Consequences of Energy Poverty

The most obvious and direct consequences of energy poverty are related to health, as noted by the WHO, which drew attention to the connection between indoor temperatures and excess winter mortality [45]. In extreme cases, households affected by energy poverty face the "heat or eat" dilemma, i.e., the choice between covering the electricity or food bills [46]. Persons under the threat of social exclusion and children are particularly endangered by energy poverty. O'Sullivan et al. [47] draw attention to the fact that the adverse outcomes of energy poverty include such aftereffects as: decreased caloric intake, increased risk of malnutrition, excess weight or severe hospitalization, deterioration of health and developmental problems, as well as the increased problems with mental health and anti-social behaviors. Studies conducted in Ireland demonstrated that household energy poverty was associated with 1.41 times higher odds of child respiratory illness [48]. However, the consequences of energy poverty are far more extensive. They involve the following areas, among others: social exclusion, poor well-being, and lower chances for educational achievements [49].

2. Materials and Methods

The survey poll, which served as the foundation for this study, included 52 questions related to various aspects of energy poverty and energy awareness. The methodology adopted for its creation [50] assumed primarily utilizing questions of a qualitative character. Some pioneering studies in this field served as an inspiration for a number of questions included in the survey, particularly those concerning energy literacy [51]. The survey form was prepared using the Moodle e-learning platform of the Cracow University of Economics. For this reason, only actively enrolled students of the university could complete the survey. In January of 2020, the request to complete the questionnaire was sent to 13,187 students. In the January–December 2020 period, we received 906 full replies, which amounts to a 7% response rate. The period during which students were completing the survey was also the period when the form of education changed due to the COVID-19 pandemic—in March 2020, compulsory distance learning was introduced by the Polish government.

The majority of our respondents (67%) were women and students working full or part-time (66%). The average age was 22, while the youngest respondents were 18 and the oldest were 50. About 95% of students were aged 27 or less, and they were from different years of study: 22% were freshmen undergraduates; 26% were second-year undergraduates; 22% were third-year undergraduates; 12% were freshmen graduates; and 18% were second-year graduates. A large portion were from small settlements (villages: 48%, small towns: 14%). The remaining students were either from larger towns (19%) or big cities (19%). About 64% students were from Małopolska Voivodeship, with 14% being from Krakow itself. It should be noted that most students at Polish universities are young adults—more often female (63–65%) than male—which come from outside "the big city", though are still from the same Voivodeship. Hence, the sample reflected the general population of a university in Krakow, as well as in other major Polish cities, relatively well.

Our analytical investigation begins with simple frequency analyses of those variables, which are potentially relevant to energy poverty—either as means of measuring it or as

its potential explanatory variables. We then move on to a more in-depth analysis of their relations between them by constructing Kendall's Tau-b coefficients, which also serve as preliminary association search to a more structured analysis based on logistic regressions. In order to proxy energy poverty (i.e., our dependent) we considered two variables from the survey. Following the literature [16], the first was based on the percentage of monthly income spent on energy (Likert scale variable). We also considered this variable as a binary-response dependent in logistic regression model with a 10% cut-off level. This is often used to identify energy poverty, as discussed by Boardman [8]. We note that this is a fairly simple indicator with an arbitrary 10% threshold, and may be found insufficient for more general studies of more heterogeneous samples with, e.g., significant amounts of high-income households, costs variation, and different purchasing parity structures between analyzed regions. However, this is not the case here because we were analyzing a relatively homogenous group—individual students within the same region, which cope with potentially similar costs regarding energy consumption. This provided us with a largely similar reference income threshold. As an auxiliary dependent variable to subjectively identify energy poverty, we used a dichotomous variable from question 7, answer 2. In this question, students answered whether they experienced inappropriate temperature (heating) due to excessive costs. Thus, students identified themselves here as directly, albeit subjectively, experiencing energy poverty. These two indicators were used to measure and analyze energy poverty among students.

Potential explanatory (independent) variables from the survey reflect information on living costs, financial constraints (other than living costs), the respondent's influence over housing choice, environmental utilities, ownership status, energy conservation actions, and the last but not least, the impact of the COVID-19 pandemic. The variable which proxies the impact of the COVID-19 pandemic on higher education was constructed by identifying three time-frames of student answers:

- Before 11 March 2020—this was the pre-pandemic period in Poland, because the first restrictions for higher education and distance learning in Poland were announced on that day; this was also the date when WHO officially declared the COVID-19 pandemic. This subsample contained 294 observations.
- From 11 March 2020 to 30 September 2020—this was the first wave of the pandemic; this was when the university authorities (as well as students) were learning 'on-the-go' how to effectively organize distance learning. This subsample contained 176 observations.
- After 30 September 2020—the second wave of the pandemic; Polish universities (and students) had the experience and the time needed to properly plan and prepare for the second semester of distance learning (e.g., the decision along with the accompanying basic structure of distance learning at Cracow University of Economics was announced in early July). This subsample contained 436 observations.

We should note that though the abovementioned subsamples did not have the same number of observations, they were all big enough to draw statistically relevant conclusions.

3. Results

The analysis was centered around the prospective determinants of energy poverty among students in Krakow (PL) and how, or if, the COVID-19 pandemic has changed energy poverty among students. The results are provided in two subsections. The first one deals with preliminary frequency-based analysis. The second subsection explores the relation between the potential explanatory variables and the dependent with the aforementioned Kendall's Tau-b and logistic regression.

3.1. Preliminary Results

3.1.1. Consequences of Inadequate Temperature

Forty seven percent of students said that the temperature in their house was adequate. However, about a third (29%) responded that an inadequate temperature caused them to

feel ill and about a fifth pointed out that it caused them to get sick more often. This response was distributed equally among the students in the energy poverty group (energy expenses above 10% of income) and others. About 6% responded that they feel uncomfortable when someone pays them a visit. The feeling of discomfort was substantially more prominent in the energy poverty group (about 20%) versus less than half a percent for other groups. Considering only those who responded during the second wave of the pandemic (and second semester of studies during the pandemic), which was also when classes were only held online, we noticed a significant increase in the responses related to feeling ill due to inadequate temperature at home (32%), while only 24% responded to this question during the time when studies were conducted either on campus or during the transition period (first wave). This result may be also due to the growing fatigue and dissatisfaction with the COVID-19 pandemic.

3.1.2. Energy Saving Actions

The respondents indicated various types of energy conservation actions and the frequency with which these actions are applied. The most frequent action was switching off the lights after leaving the room (2.8 out of 3), followed by decreasing temperature during long absences (2.6). The average score among the energy poor was similar to others (a difference below 0.2).

3.1.3. Determinants of Choosing a Place to Rent

The most important factor in choosing an apartment according to the respondents was commuting availability (4.5 out of 5), followed by rent costs (4.4), and media costs including heating, electricity, and water (4.3). Students were the least concerned about air quality (2.9) and energy efficient windows.

3.1.4. Energy Awareness vs. Energy Poverty

In order to examine energy awareness among students, a simple scoring method was used, based on 10 energy awareness questions. If a student answered all of them correctly, he/she received 10 points, with zero being the lowest score possible (all questions answered incorrectly). It is worthwhile noting that people defined as the energy poor (according to the 10% income spending threshold) achieved a result of about 4.6 against 6.1 achieved by the rest of the respondents. Thus, energy awareness may have an influence on the degree of energy poverty among students.

3.1.5. Paying for Energy

About 41% of our respondents paid directly for the energy they use, 30% paid a fixed amount, and 29% do not pay for their housing. Among those that paid directly for energy, the people who were defined as the energy poor made up over half (53.3%) of respondents.

3.1.6. Place of Residence

One of the key aspects of the survey was to identify current student places of living. At the beginning of the pandemic in Poland, in March 2020 we did not notice any substantial change in this regard. This may be due to the structure of lease agreements (which usually expire at the end of academic year) or the expectations at the time that the pandemic would soon be over, and classes would resume normally. A significant change took place in October 2020, when a much larger portion of students than usual decided to remain at home with their families (from 29% to 45%). This means that during distance learning students often chose to live with their families and thus did not bear the costs of energy consumption.

3.2. Results Based on Kendal's Tau-b and Logistic Regression

Using Kendal's tau-b, we analyzed relationships between energy poverty and various socio-economic indicators. The list is presented in Table 1. We found that those students that pay relatively more for energy:

- were more likely to have higher costs of living in Krakow (Q51: 0.21);
- had less influence over the place they live (Q27: −0.14);
- were more likely to promote energy efficiency among their roommates or flatmates (Q28: 0.11);
- were more likely to give up on using air conditioning as means of environmental protection (Q24: 0.11);
- conserved energy due to financial reasons (Q24: 0.1);
- would be willing to take energy conserving steps if they knew how (Q26: 0.1);
- intensified their current actions aimed at conserving energy (Q30: 0.1).

Table 1. Kendall's Tau-b coefficients between energy poverty and other characteristics.

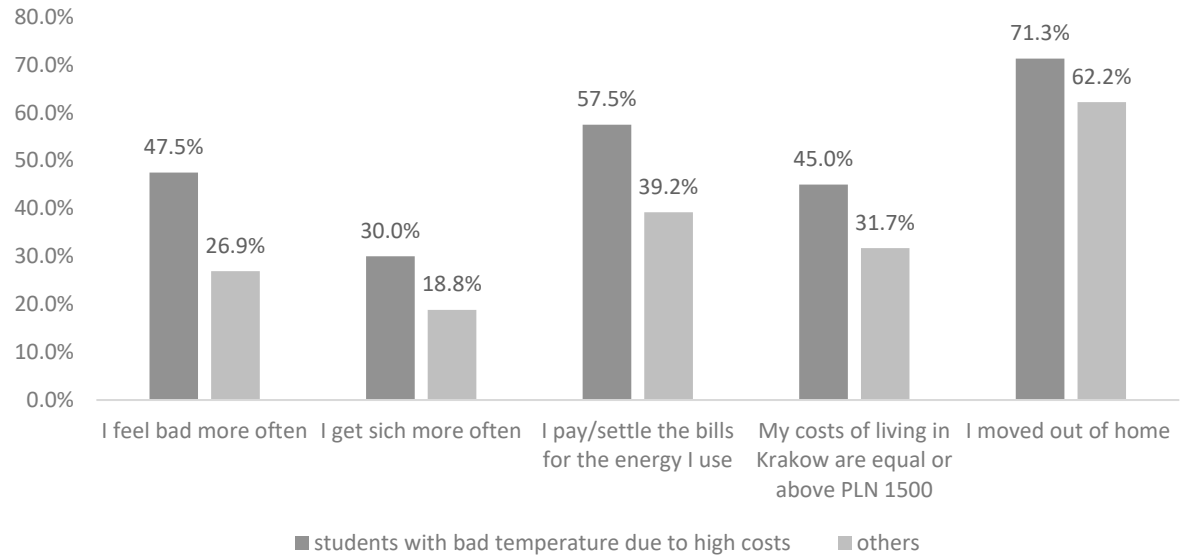
the costs of living in Kraków (question 51)	0.21
the lack of influence on the choice of the current place of living (question 27.Q)	−0.14
encouraging others (flatmates/family) to conserve thermal energy (question 28.J)	0.11
the willingness to avoid using air conditioning in order to protect the environment	0.11
financial issues as the main reason behind conserving energy (question 24.A)	0.10
the intensity of own actions aimed at limiting energy consumption (question 30)	0.10
the willingness to engage in actions for the benefit of energy conservation under the condition of possessing appropriate knowledge (question 26.A)	0.10
turning down the temperature for the night (question 28.A)	0.09
taking into consideration the issues related to energy conservation during everyday activities (question 28.I)	0.09
the willingness to lower the temperature in a flat/a house during winter in order to protect the environment (question 24.D)	0.09
encouraging others (flatmates/family) to conserve electric energy (question 28.K)	0.09
self-assessment of the level of knowledge concerning opportunities for conserving energy (question 1)	0.09
turning off heating/turning down thermostats when leaving a flat/house for extended periods of time (question 28.N)	0.09
turning off radiators/heaters when airing own flat/house (question 28.C)	0.08
costs of utilities (including heating, electric energy, water etc.) as a decisive factor when choosing a place to rent (question 27.J)	0.08
turning off radiators/heaters when airing a family flat/house (question 29.B)	0.08

Source: Own study.

Interestingly, however, we also found that those who paid more for energy (above 10%) tended, on average, to be less energy aware than others (energy awareness score of 4.6 vs. 6.1). On the basis of this fact, we could consider the following indicators of energy poverty among Krakow students: high living costs, small influence over the choice of living quarters, as well as concerns over energy efficiency and environment. It should be noted that Kendall's correlations coefficients were small and thus the above mentioned causalities were not evident. However, this was to be expected because the variables in questions were mostly in an ordinal (e.g., Likert) scale.

Furthermore, we found that those students who experienced inappropriate temperature (heating) due to excessive costs (Figure 1):

- Had higher costs of living in Krakow (higher shares in the "PLN 1500 and above" category);
- More often had to move out of their homes to study in Krakow (71.3% vs. 62.2%);
- More often felt ill or got sick (group average at 47.5% and 30%, respectively vs. 26.9% and 18.8% for others);
- More often had to cope with the full costs of the energy they used (pay for the energy; 57.5% vs. 39.2%).

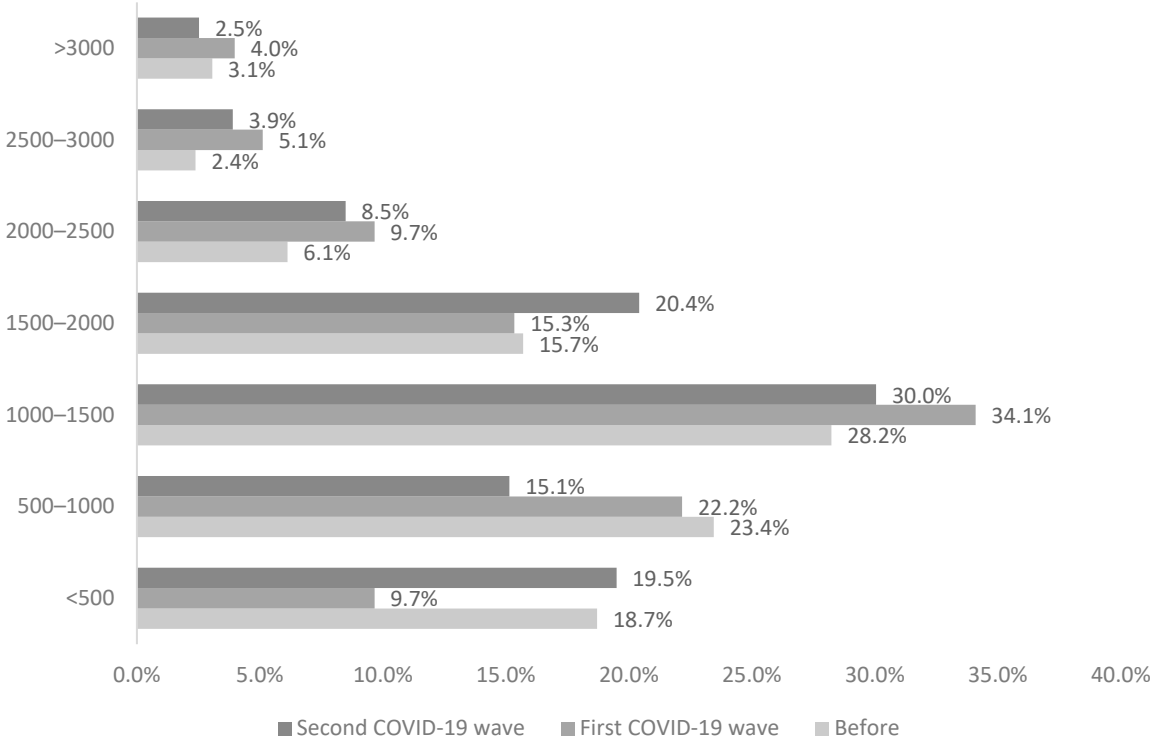


Source: Own study.

Figure 1. Characteristics of students who have concerns over bad temperature (heating) due to excessive costs.

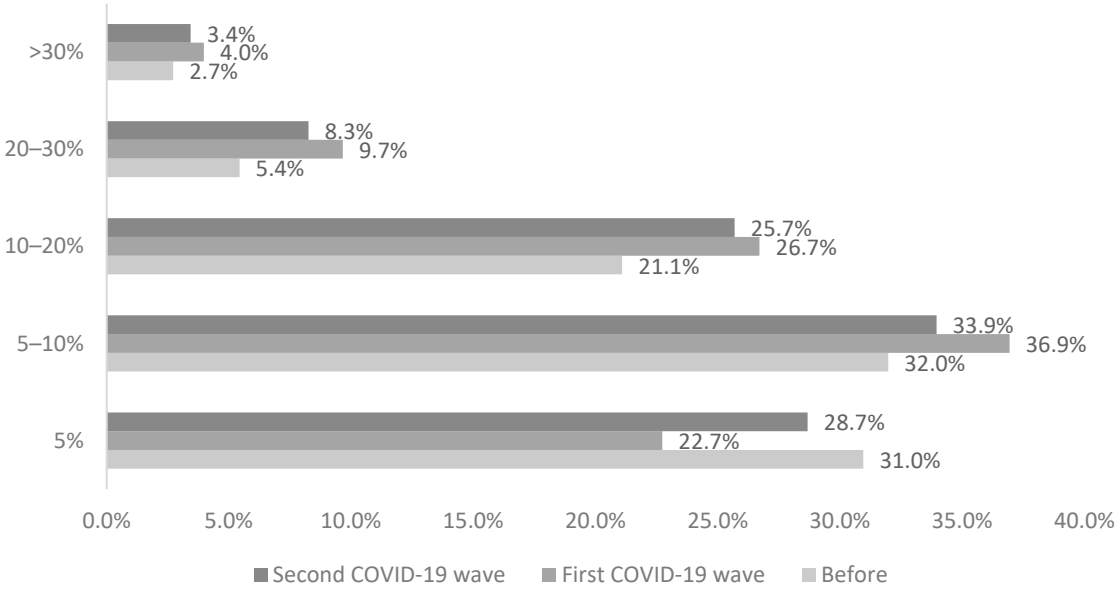
Hence, we found that those students who subjectively and directly identified themselves as experiencing energy poverty shared similar characteristics with those who were identified on the basis of Boardman's (1991) criterion (i.e., income share). This reaffirmed our belief in the above mentioned list of energy poverty determinants among students in Krakow.

With respect to the COVID-19 pandemic, we found that more students were not paying for their housing during the pandemic than before it. It seems that students currently often chose not to move out or decide to move back in with their parents. Prior to the pandemic, about one third of students (30.6%) chose to live at home. While this remained virtually unchanged during the first wave, almost half of students (44.5%) remained at home during the second wave. Furthermore, students experienced temporary surges in their overall living costs due to the pandemic, especially during the first wave; see Figure 2 for further details. Energy costs also increased during the first wave and remained high throughout the second wave; see Figure 3 for further details. We also found that energy awareness among students increased during the pandemic (an energy awareness score of 6.2 vs. 5.4 prior to the pandemic).



Source: Own study.

Figure 2. Changes in living costs over the course of the pandemic.



Source: Own study.

Figure 3. Changes in energy costs as share of monthly total expenses over the course of the pandemic.

It should be noted that a one-dimensional correlation analysis based on Table 1 and Figures 1–3 can be sometimes misleading. For example, it does not account for multiple possible inter-dependencies between the dependent (energy poverty) and its potential explanatory variables (determinants). For this reason, we constructed a logistic regression model, in which the energy poverty indicator was a binary response variable based on

the question concerning the share of the energy expenses in the total monthly expenses (question 52), as mentioned previously. Since our goal was to assess the chances of energy poverty as a function of potential determinants, and we dealt with ordinal or binary-scale variables, logistic regression seemed particularly appropriate. Potential determinants were selected on the basis of the results in Table 1; Table 2 presents a summary of the final results. We note the following significant determinants of energy poverty:

- *costs of living*: students who bear higher costs were more likely to experience energy poverty on average by 4.225%;
- *influence over choice of housing*: students who had more influence over the choice of their housing were less likely to experience energy poverty on average by 2.377%;
- *air conditioning utilities (environmental)*: students who were less interested in air conditioning utilities, were more likely to experience energy poverty on average by 5.005%;
- *financial constraints*: students who conserved energy due to financial constraints were more likely to experience energy poverty on average by 6.013%;
- *energy conservation actions (environmental)*: those who were more willing to take energy conservation actions were more likely to experience energy poverty on average by 3.539%.

Table 2. Logistic regression, results summary.

Parameter	Estimate	Standard Error	*t* Ratio	*p*-Value	95% Confidence Interval	
β_0	−3.650	0.554	−6.58	0.000	−4.737	−2.563
β_1	0.198	0.051	3.92	0.000	0.099	0.297
β_2	−0.111	0.047	−2.39	0.017	−0.203	−0.020
β_3	0.068	0.068	1	0.317	−0.065	0.202
β_4	0.235	0.062	3.76	0.000	0.112	0.357
β_5	0.282	0.067	4.19	0.000	0.150	0.414
β_6	0.166	0.090	1.84	0.066	−0.011	0.343
β_7	−0.016	0.118	−0.14	0.892	−0.248	0.216
β_8	0.243	0.211	1.15	0.250	−0.171	0.656
β_9	0.202	0.171	1.18	0.238	−0.133	0.537
Average Partial Effects for Sample Observations						
Variable	**Partial Effect**	**Standard Error**	***t*Ratio**	***p*-Value**	**95% Confidence Interval**	
x_1	0.042	0.011	3.9	0.000	0.021	0.064
x_2	−0.024	0.010	−2.39	0.017	−0.043	−0.004
x_3	0.015	0.015	1	0.317	−0.014	0.043
x_4	0.050	0.013	3.74	0.000	0.024	0.076
x_5	0.060	0.014	4.16	0.000	0.032	0.088
x_6	0.035	0.019	1.83	0.067	−0.002	0.073
x_7	−0.003	0.025	−0.14	0.892	−0.053	0.046
x_8	0.053	0.046	1.14	0.256	−0.038	0.143
x_9	0.043	0.036	1.18	0.237	−0.028	0.114

Source: Own study. Note: parameter β_0 is the intercept, parameters $\beta_1, \ldots, \beta_9$ are the coefficients of the following variables: x_1—costs of living in Krakow, x_2—influence over the choice of housing, x_3—endorsing pro-environmental energy saving actions among others, x_4—willingness to remove air conditioning utilities to protect the environment, x_5—saving energy due to financial reasons, x_6—willingness to implement energy saving actions if one knew how to do it, x_7—level of intensity of current actions aimed at decreasing energy consumption, x_8—dummy variable for the first wave of COVID-19 pandemic in Poland, x_9—dummy variable for the second wave of COVID-19 pandemic in Poland.

Somewhat surprisingly, factors such as *intensity of current actions undertaken to decrease energy consumption* or *promotion of pro-environmental energy saving actions* did not seem to have a significant connection to the energy poverty among students in Krakow.

To conclude, the determinants of energy poverty among students in Krakow can be summarized as: financial (living costs, conserving energy to save money), logistical (choice over housing quarters) and environmental (energy conservation actions, air conditioning utilities). In addition, we also noted that the environmental determinants might also be somewhat financially motivated. As for COVID-19, the results were not as conclusive as it would seem from the initial frequency-based analysis. It seems the pandemic has increased the overall energy poverty among students in Krakow, especially in the initial wave. Although the coefficients were rather low given their standard errors, we should note that the 95% confidence interval was largely above zero for both COVID-19 waves, indicating that it is quite likely that COVID-19 increased energy poverty among students. This coincided with a temporary surge in the overall costs of living in Krakow, which was also likely due to COVID-19 and the fact that many students found themselves jobless almost overnight due to the widespread closure of the economy. We also reported that a significant share of students moved back in with their parents (they do not pay for their housing anymore) for the second semester during the pandemic. This has likely offset some of the financial burdens of the pandemic in its initial stage.

4. Discussion

The problem of experiencing discomfort when someone is visiting, indicated by the Krakow students afflicted by energy poverty (by nearly 20% of them) may lead to weakening social relations and, in consequence, even to severe social withdrawal that is possible in extreme cases of this type [52]. However, we must bear in mind that the feeling of discomfort is based on the individual preferences regarding temperature which differ for every person [53]. Students who experience inappropriate temperature (heating) due to excessive costs more often than others feel ill or become sick (group average at 47.5% and 30%, respectively vs. 26.9% and 18.8% for others). Due to increasing health problems recognized as the consequences of COVID-19 infection [54], the negative effects of energy poverty among students may intensify. The observed relationship of students paying relatively more for energy while having less influence over the place they reside in, may be explained by the vastly varying degree of energy-efficiency of Polish housing buildings [55]. In the historic center of Kraków, entered into the UNESCO World Heritage List, there is no option to install further insulation due to the valuable historical facades. This fact means, in conjunction with the high ceilings in these houses, that these apartments come with significantly increased costs of heating [56]. Students who have more influence over their housing are less likely to experience energy poverty, on average by 2.4%.

In the energy poverty determinants specified in this study, the financial factors should be listed first. They are particularly important in Poland, owing to the spatial embeddedness of post-communist inequalities [57], which are characterized by the diminishing income of households and simultaneous increase of energy prices. The energy poverty effect is further exacerbated by the inefficient housing stock, which is the legacy of the centrally planned economy before 1989. The actions heading towards providing better insulation for buildings rented to students will be beneficial for the process of curtailing the energy poverty of students. The studies conducted among the landlords renting apartments to students in seven EU countries showed that grants and financial incentives are pivotal in convincing landlords to make investments in this area [58].

The logistical determinants of energy poverty are primarily related to the criteria of selecting an apartment for rental by Kraków students. The analysis of the significance of the individual factors affecting the choice of an apartment by students demonstrated that the issues of energy efficiency (including advanced, energy-efficient windows—rating 2.9/5) had relatively little importance. Similar research [2] conducted in Sheffield (Great Britain) demonstrated that the energy efficiency factors had a markedly higher influence on

making decisions with regard to housing choices (e.g., presence of double glazing—3.77/5, presence of energy efficiency measures/e.g., insulation, new boiler—3.64/5).

Persons who declare that they could resign from using air conditioning due to environmental protection concerns are simultaneously 5% more likely to fall under the threat of becoming impoverished in terms of energy. This state of affairs can be explained by the awareness of the costs related to using air conditioning and the fact that persons afflicted by energy poverty may be willing to eliminate costs which they do not consider to be indispensable. However, the attitude of limiting the use of air conditioning should not be promoted due to the need to limit expenses [59] but rather the adverse effects of air conditioning on the natural environment.

The trend of a number of students returning to family homes due to the introduction of distance learning during the pandemic may be related to the need to confront the problems affecting their parents such as the reduction of family income as a result of becoming unemployed or the reduction of salaries [60]. In such cases, instead of reducing the risk of the energy poverty threat by returning home and removing the need to independently bear the costs of bills, the risk of energy poverty may even increase. Students have experienced temporary surges in the overall living costs due to the pandemic, especially during the first wave. Energy costs have also increased during the first wave and remained high throughout the second wave. We have also found that the energy awareness among students increased during the pandemic (energy awareness score of 6.2 vs. 5.4 prior to the pandemic).

The studies on the influence of the COVID-19 pandemic on energy poverty go hand in hand with other similar scientific publications [61,62] dominated by the views that the COVID-19 pandemic may lead to the impoverishment of millions of people. The insufficiency of the funds allocated towards healthcare in numerous countries, a lack of proper sanitation, and high population density lead to increases in the number of infections and this fact may very well lead to additional millions of people falling into the vicious cycle of poverty, including energy poverty. Currently it is hard to estimate how the COVID-19 pandemic will translate into the state of the economy, the level of unemployment, and ultimately, into family incomes. For this reason, further monitoring of the poverty levels appears to be perfectly justified.

4.1. Research Limitations and Future Research Guidelines

The research conducted for this paper has its limitations. First, the students surveyed came from a single university, which means that the findings cannot be generalized across the student body. However, as there are relatively few studies of this kind, even incomplete data can be useful for designing the directions for student support to minimize the effects of energy poverty. Second, the study described in this paper was conducted in three different time periods and, therefore, the respondents' subjective perceptions of heating issues may vary across seasons.

Further research on the issues raised here should look at similar issues in different academic centers, preferably in a comparable climate zone.

4.2. Policy Recommendations

Efforts to alleviate energy poverty among students should be diversified and aim to improve the availability and quality of student residences, as well as support those who experience energy poverty in rented accommodation. An adequate supply of affordable places in dormitories would provide an alternative to renting apartments that do not meet adequate thermal insulation standards and thus reduce the demand for them. The decreasing demand, in turn, will motivate their owners to make the necessary improvements. In view of this fact, the tax relief in force since January 2019, namely the tax deductibility of thermal retrofit costs in single-family residential buildings, should be maintained. The system of need-based grants should not include preferences for persons living in premises

with substandard thermal properties, but rather constitute a buffer allowing those people to live with a degree of comfort in such premises.

It also seems reasonable to continue support for those who have switched to a green heating source based on the income criterion. The currently applied formula is based on a subsidy rate for 1 m^2 per year as a function of the estimated increase in the cost of heating using one of the green systems.

5. Conclusions

This paper explores the relationships between several energy poverty variables among university students in Krakow (Poland). The most important findings include the following: (1) those students who paid more for energy (above 10% of expenses) tended to be less energy aware than others; (2) students who experienced inappropriate temperature (heating) due to excessive costs had to move out of their homes more often to study in Krakow; (3) more students did not pay for their housing during the pandemic than before it; (4) during the COVID-19 pandemic, especially its first wave, students experienced temporary surges in the overall living costs. The latter phenomenon was accompanied by a significant reduction in income for a number of students who lost their casual jobs due to the massive lockdown of the economy. The study has also shown that students who had more influence over the choice of their housing were less likely to experience energy poverty. Those who found it difficult or impossible to cover the heating expenses (which reflect the high costs of living in Krakow), complained of discomfort and/or fatigue and tended to fall ill more often that those who could afford them.

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References

1. Kousis, I.; Laskari, M.; Ntouros, V.; Assimakopoulos, M.-N.; Romanowicz, J. An analysis of the determining factors of fuel poverty among students living in the private-rented sector in Europe and its impact on their well-being. *Energy Sources Part B Econ. Plan. Policy* **2020**, *15*, 113–135. [CrossRef]
2. Morris, J.; Genovese, A. An empirical investigation into students' experience of fuel poverty. *Energy Policy* **2018**, *120*, 228–237. [CrossRef]
3. Sovacool, B.; Vera, I. *Electricity and Education: The Benefits, Barriers, and Recommendations for Achieving the Electrification of Primary and Secondary Schools*; UNDESA: New York, NY, USA, 2014; Available online: https://sustainabledevelopment.un.org/content/documents/1608Electricity%20and%20Education.pdf (accessed on 10 March 2021).
4. Kod'ousková, H.; Lehotský, L. Energy poverty in the Czech Republic: Individual responsibility or structural issue? *Energy Res. Soc. Sci.* **2021**, *72*, 101877. [CrossRef]
5. Piwowar, A. Proceedings of the International Scientific Conference Hradec Economic Days 2020. In *Hradec Economic Days 2020, Hradec Králové, Czech Republic, 2 April 2020*; Maresova, P., Jedlicka, P., Firlej, K., Soukal, I., Eds.; University of Hradec Kralove: Hradec Králové, Czech Republic, 2020; pp. 634–641.
6. Karpinska, L.; Śmiech, S. Invisible energy poverty? Analysing housing costs in Central and Eastern Europe. *Energy Res. Soc. Sci.* **2020**, *70*, 101670. [CrossRef]

7. Bazilian, M.; Nussbaumer, P.; Cabraal, A.; Centurelli, R.; Detchon, R.; Gielen, D.; Rogner, H.; Howells, M.; McMahon, H.; Modi, V. Measuring energy access: Supporting a global target. *Earth Inst. Columbia Univ. N. Y.* **2010**. Available online: https://www.researchgate.net/profile/Mark-Radka/publication/266576066_Measuring_Energy_Access_Supporting_a_Global_Target/links/54b6e14c0cf2e68eb27fff18/Measuring-Energy-Access-Supporting-a-Global-Target.pdf (accessed on 10 March 2021).
8. Castaño-Rosa, R.; Solís-Guzmán, J.; Rubio-Bellido, C.; Marrero, M. Towards a multiple-indicator approach to energy poverty in the European Union: A review. *Energy Build.* **2019**, *193*, 36–48. [CrossRef]
9. Herrero, S.T. Energy poverty indicators: A critical review of methods. *Indoor Built Environ.* **2017**, *26*, 1018–1031. [CrossRef]
10. Sadath, A.C.; Acharya, R.H. Assessing the extent and intensity of energy poverty using Multidimensional Energy Poverty Index: Empirical evidence from households in India. *Energy Policy* **2017**, *102*, 540–550. [CrossRef]
11. Tang, X.; Liao, H. Energy poverty and solid fuels use in rural China: Analysis based on national population census. *Energy Sustain. Dev.* **2014**, *23*, 122–129. [CrossRef]
12. Bouzarovski, S.; Petrova, S.; Sarlamanov, R. Energy poverty policies in the EU: A critical perspective. *Energy Policy* **2012**, *49*, 76–82. [CrossRef]
13. Robinson, C.; Bouzarovski, S.; Lindley, S. 'Getting the measure of fuel poverty': The geography of fuel poverty indicators in England. *Energy Res. Soc. Sci.* **2018**, *36*, 79–93. [CrossRef]
14. Villalobos, C.; Chávez, C.; Uribe, A. Energy poverty measures and the identification of the energy poor: A comparison between the utilitarian and capability-based approaches in Chile. *Energy Policy* **2021**, *152*, 112146. [CrossRef]
15. United Nations. *Transforming Our World: The 2030 Agenda for Sustainable Development*; United Nations: New York, NY, USA, 2015.
16. Boardman, B. *Fuel Poverty: From Cold Homes to Affordable Warmth*; Belhaven Press: London, UK, 1991.
17. WHECA. Warm Homes and Energy Conservation Act 2000: WHECA. 2000. Available online: https://www.legislation.gov.uk/ukpga/2000/31/enacted/data.pdf (accessed on 16 March 2021).
18. Public Health England. *The Cold Weather Plan for England: Protecting Health and Reducing Harm from Cold Weather*; Public Health England: London, UK, 2018.
19. Scottish Fuel Poverty Definition Review Panel. *A New Definition of Fuel Poverty in Scotland: A Review of Recent Evidence*; Scottish Government: Edinburgh, UK, 2017.
20. DOE. *English House Condition Survey 1991: Energy Report*; Department for Communities and Local Government: London, UK, 1996.
21. Barbosa, R.; Vicente, R.; Santos, R. Climate change and thermal comfort in Southern Europe housing: A case study from Lisbon. *Build. Environ.* **2015**, *92*, 440–451. [CrossRef]
22. Sakka, A.; Santamouris, M.; Livada, I.; Nicol, F.; Wilson, M. On the thermal performance of low income housing during heat waves. *Energy Build.* **2012**, *49*, 69–77. [CrossRef]
23. Hills, J. *Getting the Measure of Fuel Poverty: Getting the Measure of Fuel Poverty: Final Report of the Fuel Poverty Review*; Hills Review Fuel Poverty: London, UK, 2012.
24. Stelmach, G.; Zanocco, C.; Flora, J.; Rajagopal, R.; Boudet, H.S. Exploring household energy rules and activities during peak demand to better determine potential responsiveness to time-of-use pricing. *Energy Policy* **2020**, *144*, 111608. [CrossRef]
25. Middlemiss, L. A critical analysis of the new politics of fuel poverty in England. *Crit. Soc. Policy* **2017**, *37*, 425–443. [CrossRef]
26. Bennett, M.; Cooke, D.; Waddams Price, C. Left out in the cold? New energy tariffs, low-income households and the fuel poor. *Fisc. Stud.* **2002**, *23*, 167–194. [CrossRef]
27. Waddams Price, C.; Brazier, K.; Wang, W. Objective and subjective measures of fuel poverty. *Energy Policy* **2012**, *49*, 33–39. [CrossRef]
28. Roberts, D.; Vera-Toscano, E.; Phimister, E. Fuel poverty in the UK: Is there a difference between rural and urban areas? *Energy Policy* **2015**, *87*, 216–223. [CrossRef]
29. Sharma, S.V.; Han, P.; Sharma, V.K. Socio-economic determinants of energy poverty amongst Indian households: A case study of Mumbai. *Energy Policy* **2019**, *132*, 1184–1190. [CrossRef]
30. Mendoza, C.B.; Cayonte, D.D.D.; Leabres, M.S.; Manaligod, L.R.A. Understanding multidimensional energy poverty in the Philippines. *Energy Policy* **2019**, *133*, 110886. [CrossRef]
31. Oum, S. Energy poverty in the Lao PDR and its impacts on education and health. *Energy Policy* **2019**, *132*, 247–253. [CrossRef]
32. Jung, H.S.; Jung, Y.S.; Yoon, H.H. COVID-19: The effects of job insecurity on the job engagement and turnover intent of deluxe hotel employees and the moderating role of generational characteristics. *Int. J. Hosp. Manag.* **2021**, *92*, 102703. [CrossRef] [PubMed]
33. Chang, C.-L.; McAleer, M.; Ramos, V. A Charter for Sustainable Tourism after COVID-19. *Sustainability* **2020**, *12*, 3671. [CrossRef]
34. UNESCO. *COVID-19 Educational Disruption and Response*; UNESCO: Paris, France, 2020.
35. Mangrum, D.; Niekamp, P. JUE insight: College student travel contributed to local COVID-19 spread. *J. Urban. Econ.* **2020**, 103311. [CrossRef] [PubMed]
36. Dave, D.; Friedson, A.; Matsuzawa, K.; Sabia, J. *When Do Shelter-in-Place Orders Fight COVID-19 Best? Policy Heterogeneity Across States and Adoption Time*; National Bureau of Economic Research: Cambridge, MA, USA, 2020.
37. Courtemanche, C.; Garuccio, J.; Le, A.; Pinkston, J.; Yelowitz, A. Strong Social Distancing Measures in The United States Reduced The COVID-19 Growth Rate: Study evaluates the impact of social distancing measures on the growth rate of confirmed COVID-19 cases across the United States. *Health Aff.* **2020**, *39*, 10–1377. [CrossRef]

38. Asanov, I.; Flores, F.; McKenzie, D.; Mensmann, M.; Schulte, M. Remote-learning, time-use, and mental health of Ecuadorian high-school students during the COVID-19 quarantine. *World Dev.* **2021**, *138*, 105225. [CrossRef]
39. Fiorillo, A.; Gorwood, P. The consequences of the COVID-19 pandemic on mental health and implications for clinical practice. *Eur. Psychiatry* **2020**, *63*. [CrossRef]
40. Galea, S.; Merchant, R.M.; Lurie, N. The mental health consequences of COVID-19 and physical distancing: The need for prevention and early intervention. *JAMA Intern. Med.* **2020**, *180*, 817–818. [CrossRef]
41. Szcześniak, D.; Gładka, A.; Misiak, B.; Cyran, A.; Rymaszewska, J. The SARS-CoV-2 and mental health: From biological mechanisms to social consequences. *Prog. Neuro Psychopharmacol. Biol. Psychiatry* **2020**, 110046. [CrossRef]
42. Bonaccorsi, G.; Pierri, F.; Cinelli, M.; Flori, A.; Galeazzi, A.; Porcelli, F.; Schmidt, A.L.; Valensise, C.M.; Scala, A.; Quattrociocchi, W. Economic and social consequences of human mobility restrictions under COVID-19. *Proc. Natl. Acad. Sci. USA* **2020**, *117*, 15530–15535. [CrossRef] [PubMed]
43. Mamica, Ł.; Tridico, P. (Eds.) *Economic Policy and the Financial Crisis*; Routledge: Oxfordshire, UK, 2017.
44. Bradbury-Jones, C.; Isham, L. The pandemic paradox: The consequences of COVID-19 on domestic violence. *J. Clin. Nurs.* **2020**. [CrossRef] [PubMed]
45. Braubach, M.; Jacobs, D.E.; Ormandy, D. (Eds.) *World Health Organization. Environmental Burden of Disease Associated with Inadequate Housing: A Method Guide to the Quantification of Health Effects of Selected Housing Risks in the Who European Region*; WHO: Geneva, Switzerland, 2011.
46. Frank, D.A.; Neault, N.B.; Skalicky, A.; Cook, J.T.; Wilson, J.D.; Levenson, S.; Meyers, A.F.; Heeren, T.; Cutts, D.B.; Casey, P.H. Heat or eat: The Low Income Home Energy Assistance Program and nutritional and health risks among children less than 3 years of age. *Pediatrics* **2006**, *118*, e1293–e1302. [CrossRef]
47. O'Sullivan, K.C.; Howden-Chapman, P.; Sim, D.; Stanley, J.; Rowan, R.L.; Clark, I.K.H.; La Morrison, L.; Waiopehu College 2015 Research Team. Cool? Young people investigate living in cold housing and fuel poverty. A mixed methods action research study. *SSM Popul. Health* **2017**, *3*, 66–74. [CrossRef] [PubMed]
48. Mohan, G. Young, poor, and sick: The public health threat of energy poverty for children in Ireland. *Energy Res. Soc. Sci.* **2021**, *71*, 101822. [CrossRef]
49. Rugkåsa, J.; Shortt, N.; Boydell, L. *Engaging Communities: An Evaluation of a Community Development Model for Tackling Rural Fuel Poverty*; Institute of Public Health in Ireland: Belfast, Nothern Ireland, 2004.
50. Schwarz, N.E.; Sudman, S.E. *Answering Questions: Methodology for Determining Cognitive and Communicative Processes in Survey Research*; Jossey-Bass/Wiley: San Francisco, CA, USA, 1996.
51. DeWaters, J.E.; Powers, S.E. Energy literacy of secondary students in New York State (USA): A measure of knowledge, affect, and behavior. *Energy Policy* **2011**, *39*, 1699–1710. [CrossRef]
52. Tod, A.M.; Thomson, H. *Health Impacts of Cold Housing and Energy Poverty*; Energy Poverty Handbook; Csiba, K., Ed.; The European Union. The Greens/EFA Group in the European Parliament: Brussels, Belgium, 2017; pp. 39–56.
53. Gładyszewska-Fiedoruk, K.; Sulewska, M.J. Thermal Comfort Evaluation Using Linear Discriminant Analysis (LDA) and Artificial Neural Networks (ANNs). *Energies* **2020**, *13*, 538. [CrossRef]
54. Del Rio, C.; Collins, L.F.; Malani, P. Long-term health consequences of COVID-19. *Jama* **2020**, *324*, 1723–1724. [CrossRef]
55. Miszczuk, A. Influence of air tightness of the building on its energy-efficiency in single-family buildings in Poland. *MATEC Web Conf.* **2017**, *117*, 120. [CrossRef]
56. Makowska, B. Importance and Protection of Architectural Detail—Krakow Case Study. *IOP Conf. Ser. Mater. Sci. Eng.* **2019**, *471*, 82029. [CrossRef]
57. Bouzarovski, S.; Tirado Herrero, S. Geographies of injustice: The socio-spatial determinants of energy poverty in Poland, the Czech Republic and Hungary. *Post Communist Econ.* **2017**, *29*, 27–50. [CrossRef]
58. Ntouros, V.; Laskari, M.; Iordache-Platis, M.; Assimakopoulos, M.-N.; Romanowicz, J.; Lontorfos, V. Alleviating energy poverty experienced by students living in private rented accommodation: The role of the housing provider. *Proc. Int. Conf. Bus. Excell.* **2019**, *13*, 1009–1020. [CrossRef]
59. Calm, J.M. Emissions and environmental impacts from air-conditioning and refrigeration systems. *Int. J. Refrig.* **2002**, *25*, 293–305. [CrossRef]
60. Daniel, J. Education and the COVID-19 pandemic. *Prospects* **2020**, 1–6. [CrossRef] [PubMed]
61. Nagaj, R.; Korpysa, J. Impact of COVID-19 on the Level of Energy Poverty in Poland. *Energies* **2020**, *13*, 4977. [CrossRef]
62. Anser, M.K.; Yousaf, Z.; Khan, M.A.; Nassani, A.A.; Alotaibi, S.M.; Abro, M.M.Q.; Vo, X.V.; Zaman, K. Does communicable diseases (including COVID-19) may increase global poverty risk? A cloud on the horizon. *Environ. Res.* **2020**, *187*, 109668. [CrossRef] [PubMed]