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Growing up in discomfort: Exploring energy poverty and thermal comfort among students in Portugal

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ABSTRACT

Energy poverty is a growing multidimensional concern worldwide, with children and young people particularly vulnerable. This age group spends a significant amount of time in both their houses and school buildings. To date, there has been little research on the dual vulnerability to inadequate thermal comfort conditions in these two environments. In Portugal, the exposure to inadequate thermal comfort in school buildings varies due to disparities in renovation efforts. This work aims to assess upper secondary school students' perception of energy poverty at home and thermal comfort inside classrooms. A survey method was employed comparing a sample of students from one renovated and one non-renovated school located in the Lisbon district. Surveys were complemented with interviews and surveys completed by other school stakeholders. The results indicate that between 4.2 and 14 % of students live in permanent discomfort (i.e., uncomfortable both at school and home). Despite the discomfort levels observed in students from the renovated school, it is possible to say that the renovation alleviated levels of discomfort. Students with health conditions and disadvantaged backgrounds were more likely to report discomfort than those who did not. This study raises awareness of an underexplored vulnerable group and provides valuable insights into the issue of energy poverty among young people. It addresses the need to incorporate this age group in energy-related school policies and future renovation programs.

1. Introduction

Currently, the world is facing significant challenges as a result of climate change, among these challenges those related to energy will be prominent. Energy production is the most significant contributor to global CO_2 emissions [1] and climate change will impact energy production [2] and demand, namely the need for cooling services [2,3]. The inability to access essential energy services is commonly referred to as energy poverty and is intrinsically related to climate change [4–6]. Energy poverty disproportionately impacts various groups, due to factors such as age, health, and income [7].

This issue affects approximately 50 to 125 million people in Europe alone [8]. In 2022, 9 % of households in the EU27 countries faced challenges in adequately heating their homes [9]. Additionally, 16.2 % of EU households had low absolute energy expenditure, while 14.6 % of EU households reported high energy expenditures compared to their income levels [9]. Three key drivers are usually considered as the shared causes of energy poverty (high energy prices, low household income, and low energy efficiency of dwellings), with energy efficiency directly related to the building conditions and indoor thermal comfort. Therefore, renovating buildings and replacing heating and cooling equipment contributes to the reduction of energy needs, to the improvement of thermal comfort and the alleviation of energy poverty [10–12].

In Europe, it is estimated that individuals spend approximately 90 % of their time indoors [13]. Therefore, assessing thermal comfort in places where people spend extended periods is crucial, for example in schools. Indoor environmental quality parameters have been found to impact students' well-being and academic performance [14–16]. Across Europe, the average duration of compulsory education is 11 years [17], indicating that children may be exposed to unhealthy environments during a critical development stage. Thus arguably, the drivers of energy poverty and their corresponding impacts may extend beyond the residential setting to other indoor environments such as schools. These

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institutions may also fail to provide thermal comfort due to high energy prices, low energy efficiency or due to external pressure for low energy consumption (due, for example, to a low school budget allocated to energy costs). Considering this, studying the perception of thermal comfort beyond the residential setting has become important, especially in children, as the impact of thermal comfort on their academic development may have implications for their future lives. This is particularly concerning considering that one out of three children live in unhealthy homes [18], suggesting that some children may rarely experience thermal comfort.

Compared to other EU countries, Portugal exhibits a concerning level of energy poverty. In 2022, approximately 17.5 % of the Portuguese population faced difficulties in adequately heating their homes, placing Portugal as a country with the 5th highest "inability to keep the home adequately warm" among EU member states [9], with 12.9 % of households with dependent children reporting this inability [19]. Furthermore, 25.2 % of Portuguese individuals reside in dwellings with issues such as leaking roofs, damp walls, floors or foundations, or rot in window frames or floors, the 3rd highest percentage among EU countries [9].

Unfortunately for Portuguese children and young individuals, attending school may be synonymous with exposure to thermal discomfort. The school building stock in Portugal generally consists of older buildings, with some dating back to the 19th century [20]. Moreover, schools that possess energy performance certificates demonstrate low levels of energy efficiency, with 61 % of the buildings certified classified as grade C or below on a scale ranging from A+ to F [21]. Despite the launch of a major renovation program initiated in 2007 in Portugal to renovate 332 secondary schools out of 477 by 2015 [20], only 176 schools were renovated [22]. Therefore, the low number of schools renovated combined with Portugal's high rates of energy poverty in the European context increases the likelihood of students experiencing discomfort at school and encountering further discomfort upon returning home.

Given the importance of thermal comfort in daily life and the links between thermal comfort and health, it is imperative to undertake studies that comprehensively evaluate thermal comfort levels in residential settings and other locations where individuals spend substantial amounts of time. Studies focusing on younger populations are particularly important, especially as the existing body of literature on energy poverty primarily concentrates on adult views and experiences [23,24]. Additionally, objective studies of energy poverty are key, as expectations regarding energy services are subjective [8], and behaviours vary between different age groups [25]. Assessing energy poverty and thermal comfort is important in all age groups, however, the 15–18 age group is an appropriate group to assess as students in this age group are more able to recognise these issues. Furthermore, this age group can provide consent for participation in the survey, which is typically not the case for younger cohorts. Despite the value of studying perceived energy poverty and thermal comfort within the 15–18 age group, research in this area remains scarce, with no study to date having simultaneously examined vulnerability to energy poverty and vulnerability to inadequate thermal comfort beyond the home environment.

In response to the identified research gap, this study aims to evaluate the perceptions of energy poverty at home and thermal comfort in schools among upper-secondary education students. Surveys were conducted in two schools, one renovated (RS) and one non-renovated (NRS) and were supplemented with surveys targeting the teachers. This comprehensive approach aimed to provide a thorough and robust understanding of the issues. Considering the aim of the study, the objectives included assessing perceived vulnerability to energy poverty in young people (aged 15–18), evaluating perceived thermal comfort in schools for this age group, studying the dual vulnerability of the student population, examining the impact of school renovations on the thermal comfort of students, and characterising the student population reporting discomfort. The findings of this study will expand the limited existing literature on energy poverty and young people, offering new insights into dual energy vulnerability, and students' perceptions of comfort both at school and home and will highlight observed disparities among various groups based on gender, health status, and socioeconomic conditions.

2. Literature review

2.1. Energy poverty, children, and young people

Specific household characteristics cause vulnerability in terms of access to energy services. Evidence shows that families with children and teenagers are more vulnerable to energy poverty [26,27] but little research has explored children's energy use [28] and they are usually passive subjects in energy policy [29]. Additionally, they have a greater burden of cumulative exposure to energy poverty than adults, with a greater impact on their well-being and mental health [24,30–32]. Studies identified the prevalence of respiratory conditions such as asthma in children living in a dwelling with damp and mould [33,34]. The housing conditions which teenagers experience affect their daily lives inside and outside their dwellings [38]. A study performed in Barcelona identified that energy poverty was strongly associated with poor physical and mental health and more cases of asthma and of children being overweight [35]. Therefore, improving indoor conditions reduces the prevalence of these conditions and lowers the probability of absence from school, improving academic achievement and reducing hospital admissions [36,37].

University students have also been identified as a group which is vulnerable to energy poverty, this is particularly the case for student renters. However, the research in this age group is still scarce and has only recently started to develop. Castro & Gouveia [39] conducted a study involving university students from Montevideo, Lisbon, and Padua. The study aimed to discern disparities among students from these three locations, considering both local and exchange students. The findings indicated that students from Lisbon reported a higher degree of discomfort. Lisbon was the only location where both exchange students and local students highlighted the impact of housing conditions on their well-being. Clark et al. [40] concluded that tertiary students perceive poor building conditions and lack of thermal comfort to impact their health and academic performance. A study in Poland concluded that students underheat their homes to avoid excessive costs, leading to more frequent occurrences of illness [41]. However, it was observed that tertiary students do not consider themselves to be living in energy poverty. Despite this, students engage in coping strategies which contradict this observation suggesting the opposite, such as cutting back spending on energy use [39,42].

2.2. Thermal comfort in schools

Students have been the focus of thermal comfort studies, namely secondary education students. These studies calculate thermal comfort levels in school environments according to established thermal comfort standards and then compare the results with the students' perceptions of thermal comfort, assessing if the standards accurately determine the comfort ranges identified by the relevant age group.

In a review of 48 articles on thermal comfort in schools, Zomorodian et al. [43] compared thermal comfort standards across different educational stages and climate zones. Their findings revealed that these standards are unsuitable for assessing thermal classroom environments, with an overestimation of the levels of thermal comfort observed in most secondary education levels. Additionally, studies conducted within the same climate zones found a disparity in temperature of thermal neutrality, highlighting the need for micro-level thermal comfort research. The studies reviewed also suggested that students prefer colder environments and are more sensitive to warm conditions. In a study conducted in Portugal, Pereira et al. [44] found that students felt comfortable in temperatures outside the range established by the thermal comfort norms during mid-season, with the state "slightly warm" as their preferred state. In another study in Portugal, using a thermal comfort scale that ranged from comfortable to very uncomfortable, students from a secondary school in Guimarães rated mainly their thermal comfort as comfortable (61 %) or slightly uncomfortable (23 %) [45]. Looking into other thermal comfort studies in schools in other Mediterranean countries, perceived thermal comfort in classrooms varies across different countries. In Italy, in four secondary schools, the level of discomfort during winter ranged from 10 % to 62 % [46]. In Cyprus, nearly half of the students expressed discomfort throughout the academic year, primarily attributed to deficiencies in school building insulation and elevated classroom temperatures, particularly linked to computer usage [47]. Gender differences were identified, with the low temperatures impacting disproportionately female students, often leading to the overuse of heating systems, subsequently causing males to experience discomfort [47]. In Greece, a study in a secondary school during winter reported low levels of comfort attributed to the lack of heating systems [48].

Thermal comfort in schools is more than merely a question of preference, as discomfort affects students' academic performance. Studies have established a relationship between classroom settings and academic performance in the classroom in relation to factors such as temperature [49,50] and air quality [51]. This underscores the need to ensure thermal comfort for all students, especially considering that schools may serve as shelters for students who lack comfort at home. Considering the findings of the studies reviewed, it is evident that students should be directly involved in this decision process, and qualitative methods are more valuable, given that thermal comfort standards do not accurately predict students' preferences, consumption patterns, or user behaviours.

3. Materials and methods

3.1. Methodology

The methodology employed in this study is described in Fig. 1. The process was initiated by randomly selecting one renovated school and one non-renovated school in the Lisbon district. The surveys were collected during mid-season. The data collection in each school consisted of surveys targeted at students and teachers. The student surveys were composed of 20 questions, divided into five sections (summarised below with further detail in Appendix A):

- A section characterising the students;
- A section focused on dwelling conditions;
- A section exploring perceived thermal comfort in the classroom;
- A final section assessing double vulnerability;
- An open-ended section, where students were encouraged to describe their experiences regarding energy poverty and thermal comfort at school.

In the characterisation section, the students were asked about the level of "school social support" their families received to evaluate household income levels and the number of students coming from disadvantaged backgrounds. In Portugal, this kind of support is given to students in families with an annual income below 6204.8€.

Two different methods were used to assess discomfort in the two locations. To assess the number of students experiencing energy poverty, the questions used were similar to those asked in SILC-EU. The thermal comfort in school was evaluated by considering the perceived comfort based on Fangers' 7-point scale. Different methods were used to allow comparison of the results obtained with other data such as: national

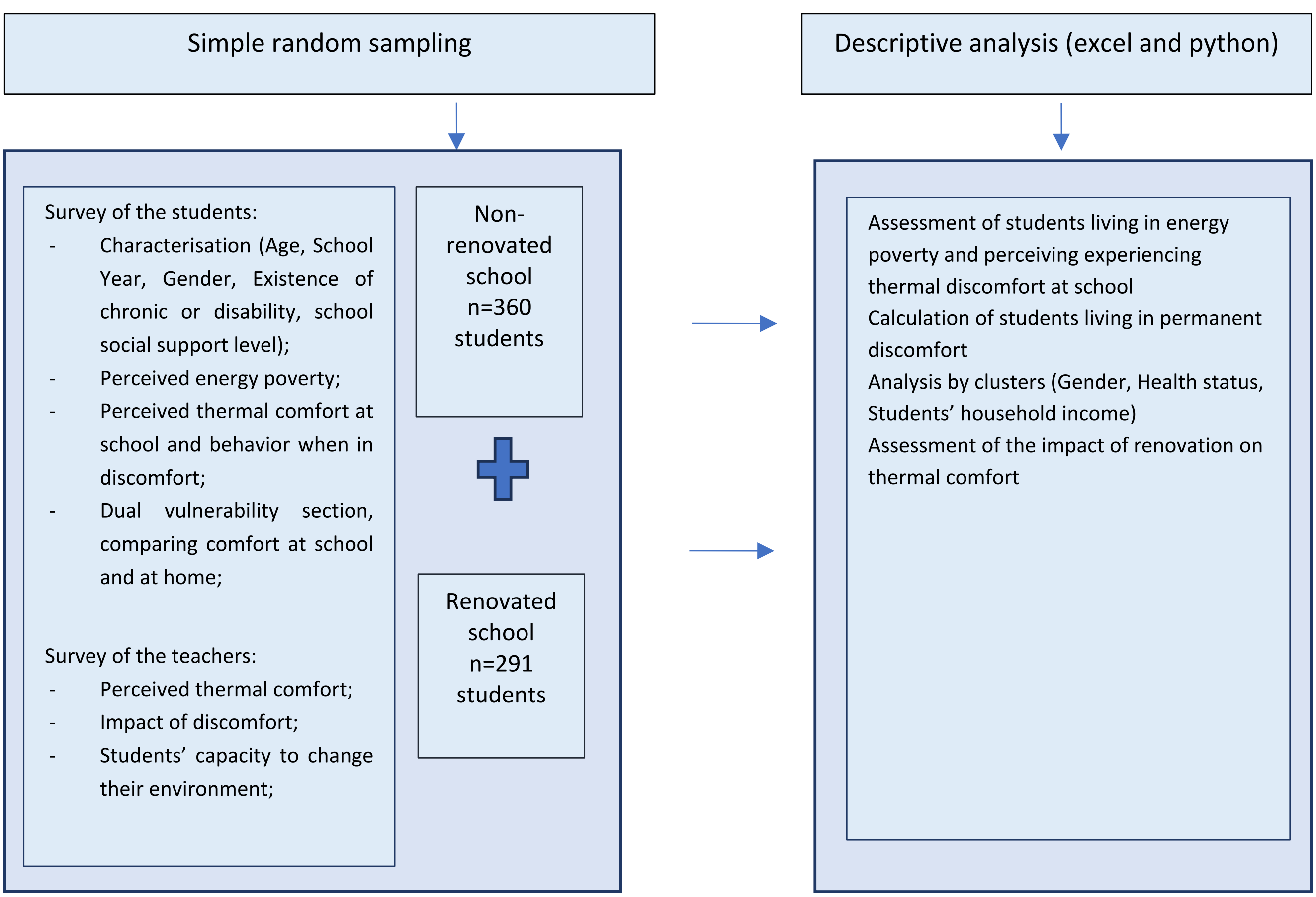


Fig. 1. Overall methodological process to assess students' vulnerability to energy poverty and thermal comfort.

statistics, in the case of energy poverty, and with other studies, in the case of thermal comfort.

Before conducting the surveys in schools, a pretest was conducted to determine the time required to complete the survey and identify any questions that needed to be revised, and some questions were clarified. The surveys were disseminated to the student population by electronic mail, and answers were collected through random sampling until the sample size achieved statistical significance in representing the number of students in each school. The sample size was calculated using Modified Cochran's sample size formula (eq. 1), considering a 95 % confidence and 5 % margin of error.

Equation 1 Modified Cochran's sample size formula.

N = population size; *e = margin of error*; *Z = z-score*; *p = population proportion* = 0,5

$$Sample\ size = \frac{\frac{Z^2 * p(1-p)}{e^2}}{1 + .}$$

The teachers were also surveyed to compare their perceptions of comfort with those of the students and to contribute to possible explanations of experiences of thermal comfort or discomfort in classrooms as, in these schools, the teachers are in charge of controlling the thermal environment (both by using the climatisation systems or operating the windows). The survey only covered one section regarding thermal comfort (Appendix B). Information regarding the number of students and the type of infrastructure presented in the school was collected from the school director's board.

After collecting the results, the next step in the methodology entailed an analysis and interpretation of the data to answer the objectives proposed. Prevalence ratios and corresponding confidence intervals (with a 95 % confidence level) were calculated to assess the impact of the renovation on students' thermal comfort and to determine if certain groups were more likely to report discomfort. This method was considered appropriate because it is well-established in energy poverty studies, the interpretation of the results is intuitive, and it is considered more accurate than others [52]. The percentage of students in discomfort at home was calculated based on the number of students who explicitly reported feeling discomfort at home (answering "no" when asked if they were comfortable) and the percentage of students reporting discomfort at school was calculated based on the students who indicated feeling "Hot", "Warm", "Cool" or "Cold" when asked about their thermal comfort in the classroom. Prevalence ratios were calculated for the students who reported discomfort, the calculation of these prevalence ratios involved an assessment of the frequency with which girls reported discomfort, the ratio of students reporting a chronic or disabling condition, and the ratio of students who benefited from school social support (based on their perceived socio-economic disadvantage). This calculation was completed for discomfort at school, at home, and in instances where discomfort was reported in both places. The prevalence ratio of students that benefit from school social support was not calculated "at school" as the students' socioeconomic background was not considered relevant to the reporting of discomfort at school. The findings were analysed individually for each school and compared between the two schools, considering the specific characteristics of the buildings, as well as the minor variations in climate and sociodemographic factors across the school regions. The analysis considered the vulnerability to energy poverty according to the Energy Poverty Vulnerability Index [53], a metric used to assess the susceptibility of Portuguese civil parishes to energy poverty. This index integrates various socioeconomic markers, climate information, energy usage patterns, building construction attributes, and the energy efficiency of diverse building types.

3.2. Case-study

Two schools were involved in this study, one renovated and one non-renovated. They were selected randomly and are both located in the Lisbon district, Portugal. The renovated school is located in the Vila Franca de Xira municipality, and the non-renovated one is in the Alenquer municipality, being located approximately 25 km from each other. In Table 1, these municipalities and the schools are characterised. The municipalities present several similarities regarding socioeconomics indicators and indicators related to the buildings, with the Alenquer school presenting a higher vulnerability to energy poverty for cooling and heating. In the renovated school, the surveys were collected between 10/03/2023 and 27/03/2023 and in the non-renovated school were collected between 12/04/2023 and 22/05/2023.

4. Results

4.1. Renovated school

Three hundred and sixty students answered the survey, and their characteristics are detailed in Table 2. Regarding self-reported health

Table 1
Characterisation of the schools and schools' municipalities.

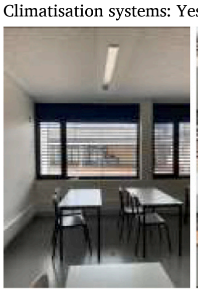
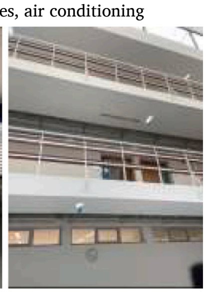
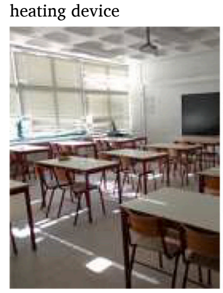
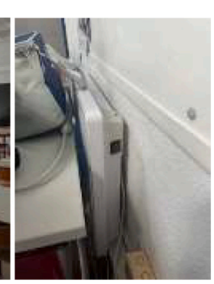
	Renovated school	Non-renovated school
Municipality characterisation	Population density: 1525 inhabitants per km^2 [54] Unemployment rate: 7.8 % [55] Buildings in need of repair: 29.1 % [56] Heating EPVI: 5.9 [53] Cooling EPVI: 6.9 [53] Duration of the heating season: 5.3 months [57] Summer climate zone: V_3 [57]	Population density: 146.09 inhabitants per km^2 [54] Unemployment rate: 7.2 % [55] Buildings in need of repair: 32.5 % [56] Heating EPVI: 9.5 [53] Cooling EPVI: 11 [53] Duration of the heating season: 5.7 months [57] Summer climate zone: V_2 [57]
School characterisation	Date of construction: 1984 Year of renovation: 2021 Number of students: 1400 (minimum sample according to the Modified Cochran's sample size formula: 302 students) Climatisation systems: Yes, air conditioning	Date of construction: 1970 Number of students: 948 (minimum sample according to the Modified Cochran's sample size formula: 274 students) Climatisation systems: No cooling system. Some classrooms have a small heating device
Schools' classrooms	 	 

Table 2
Characterisation of the students' sample and results of the energy poverty and thermal comfort section.

	Students' characteristics	Energy poverty	Thermal comfort
Renovated school	60 % female, 38 % male, 1.4 % non-binary, 0.8 % other. 78 % of students reported no health condition. 15 % benefit from school social support.	Uncomfortable at home: Summer: 21 % Winter: 19 % Equipment usage: Heating: 90 % Cooling: 86 % Presence of mould or dampness: 42 %	Uncomfortable at school: Summer: 52 % Winter: 39 % Most frequently used garment: Jacket. When uncomfortable: Tell the teacher: 65 %. Open window: 33 % Adjust climatisation:30 % Adjust blinds: 19 %. Adapt level of clothing: 59 % Do not take action: 10 %
Non-renovated school	55 % female, 43 % male, 1.4 % non-binary, 0.7 % other. 81 % of students reported no health conditions. 20 % benefit from school social support.	Uncomfortable at home: Summer: 15 % Winter: 17 % Equipment usage: Heating: 92 % Cooling: 82 % Presence of mould or dampness: 41 %	Uncomfortable at school: Summer: 84 % Winter: 61 % Garment more frequently used: Jacket When uncomfortable: Tell the teacher: 44 % Open window: 58 % Adjust climatisation:1 % Adjust blinds: 28 % Adapt level of clothing: 72 % Do not take action: 8 %

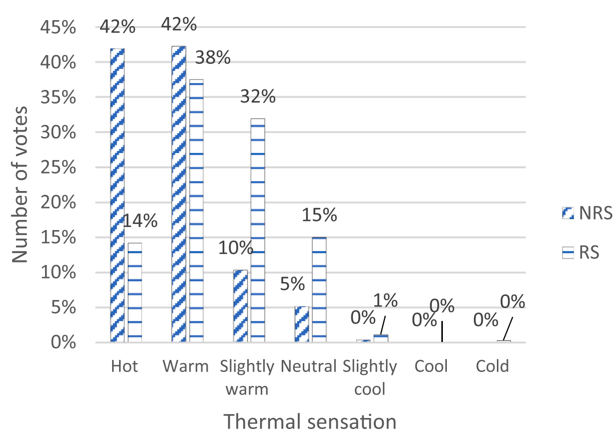


Fig. 2. NRS and RS students' thermal comfort during summer.

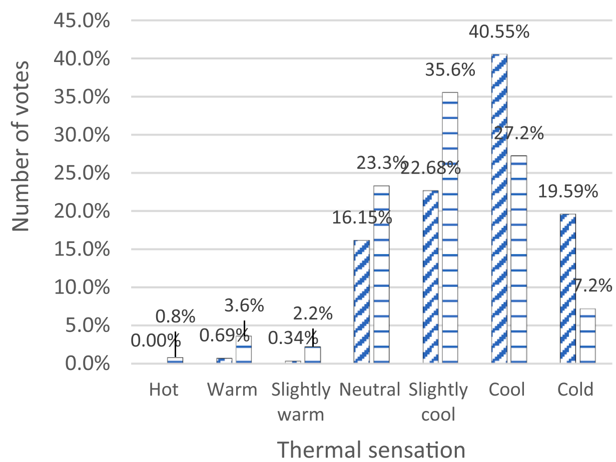


Fig. 3. NRS and RS students' thermal comfort during winter.

Table 3
Prevalence of gender, self-reported health status, and School Social Support Level among RS students who reported discomfort.

Category	Discomfort at home				Discomfort at school				Discomfort at both			
	Summer		Winter		Summer		Winter		Summer		Winter	
	% (N)	PR (95 % CI)	% (N)	PR (95 % CI)	% (N)	PR (95 % CI)	% (N)	PR (95 % CI)	% (N)	PR (95 % CI)	% (N)	PR (95 % CI)
Gender												
Female	22 % (48)	1.2 (0,80-1,9)	22 % (47)	1.9 (1.1–3.3)	51 % (111)	0.99 (0.80–1.2)	44 % (95)	1.5 (1.1–2.1)	12 % (26)	1.01 (0.56–1.8)	4 % (9)	0.93 (0.34–2.6)
Chronic or disabling conditions												
Cardiovascular	50 % (2)	3 (1.1–8.4)	25 % (1)	1.7 (0.31–9.5)	100 % (4)	2.07 (1.8–2.3)	25 % (1)	0.67 (0.12–3.7)	0 % (0)	–	0 % (0)	–
Respiratory	26 % (8)	1.6 (0.82–3.0)	16 % (5)	1.1 (0.47–2.6)	48 % (15)	1.00 (0.-2,7)	45 % (14)	1.2 (0.8–1.8)	26 % (8)	2.8 (1.4–5.6)	0 % (0)	–
Mental	50 % (5)	3.04 (1.6–6.0)	40 % (4)	2.7 (1.2–6.1)	70 % (7)	1.45 (1.1–3.6)	40 % (4)	1.08 (0.50–2.3)	30 % (3)	3.2 (1.2–8.9)	20 % (2)	5.1 (1.3–19)
School social support												
Beneficiary	31 % (17)	1.8 (1,1–2.9)	24 % (13)	1.32 (0.77–2.3)					13 % (7)	1.08 (0.50–2.3)	5 % (3)	1.3 (0.37–4.4)

Legend: %: percentage compared to the total in each category; PR: prevalence ratio; CI (95 %): confidence Interval with 95 % confidence; –: not applicable.

status, most students reported having no chronic illness or a long-term disability (78 %), 8.9 % reported having respiratory conditions, 2.8 % reported having a mental illness, and 1.1 % reported having cardiovascular conditions.

At home, this sample of students reported more discomfort during summer, and 8.6 % of students reported not feeling comfortable at home during both seasons. When asked about the equipment used in their houses, 10 % of students acknowledged not using heating equipment, while 14 % reported not using cooling equipment. 3.9 % of students reported not using any equipment. The most commonly reported heating equipment was the electric heater, and the most commonly reported cooling equipment was the portable fan.

Regarding their thermal comfort in the classroom, during summer (Fig. 2), 52 % of students expressed thermal discomfort, with more students reporting feeling warm or slightly warm. The percentage of discomfort during winter was lower, with 39 % of accumulated discomfort (Fig. 3). When asked about the impact of the temperature in the classroom, 68 % of students perceived that the temperature affects their ability to pay attention and 62 % of the students stated that the classroom temperature impacts their academic performance. Considering the garments that students use in the classroom when they feel uncomfortable, the most frequently used items were jackets, with 45 % of the students saying they use them frequently and 39 % saying they use them very frequently. Other garments and accessories, such as scarves and blankets or paper fans, were used rarely or never.

Students were also asked about the type of actions they took in class when they felt uncomfortable, and they were allowed to select more than one option. They mainly reported informing the teacher and asking for a change in the classroom temperature or adding or removing garments as appropriate. Nevertheless, 10 % of students surveyed reported taking no action when the temperature of the classroom was not comfortable.

In the section of the survey that compared levels of thermal comfort in school and at home, most students reported that the temperature at home is more comfortable than at school during summer (69 %) and winter (76 %). However, 8 % of students perceived that the temperature is more comfortable at school during summer and 6 % perceived that it is more comfortable during winter. Furthermore, 12 % of students are uncomfortable at home and at school during summer and 4 % are uncomfortable in both locations during winter. The results in this section were compared with the number of students stating that they were both uncomfortable at home and at school in other sections of the survey. A slight variation was observed: 13 % of students were uncomfortable in both locations in summer and 11 % in winter. One way to assess the impact of the school renovation on thermal comfort was by comparing the number of students who selected "It is comfortable at both" and "In school" with 19 % of students selecting this option in summer and 20 % in winter.

In Table 3, the percentage of students who reported discomfort at home and at school and indicated discomfort in both places were analysed in categories. For students in the category reporting a chronic condition or a disability, students with mental illnesses were more likely to report discomfort in all the situations analysed. Students from disadvantaged backgrounds were also more likely to report discomfort than the other students.

In the open-ended question section of the survey, nineteen students gave their opinions regarding energy poverty and thermal comfort in schools. Ten of the statements were related to issues with the air conditioning, including instances where teachers did not turn on the air conditioning upon request and that some classrooms had non-functional air conditioning units: "*The teachers never turn the air conditioning on, even when we request it*" (Female, 17 years old).

One student provided her personal experience about the impact of thermal discomfort in school: "*During winter, the temperature in the classroom can be so cold that it becomes difficult to write. During summer, considering that we are a class of twenty-four students, the heat can be overwhelming, even with windows open or with the blinds down. In contrast, I feel very comfortable at home, whether it is hot or cold*" (Female, 18 years old).

Twenty answers were collected in the teachers' survey. The level of discomfort in their surveys was lower than that obtained in the students' one: 30 % of the teachers expressed discomfort during summer and 35 % during winter. Regarding the ability of students to regulate the thermal conditions within the classroom, 85 % of the surveyed teachers affirmed that students are authorized to open and close the windows and only 35 % confirmed that students can operate the air conditioning system.

4.2. Non-renovated school

At the non-renovated school, the number of students answering the survey was two hundred and ninety-one, characterised in Table 2. Regarding the students' health conditions, the most frequently reported disease was respiratory (8.9 %), followed by mental illness (3.1 %), and 1.4 % of students had cardiovascular conditions.

Table 4
Prevalence of gender, self-reported health status, and School Social Support Level among NRS students who reported discomfort.

Category	Discomfort at home				Discomfort at school				Discomfort at both			
	Summer		Winter		Summer		Winter		Summer		Winter	
	% (N)	PR (95 % CI)	% (N)	PR (95 % CI)	% (N)	PR (95 % CI)	% (N)	PR (95 % CI)	% (N)	PR (95 % CI)	% (N)	PR (95 % CI)
Gender												
Female	18 % (28)	1.5 (0.82–2.65)	19 % (31)	1.4 (0.84–2.49)	89 % (142)	1.2 (1.03–1.29)	68 % (108)	1.4 (1.10–1.67)	3 % (5)	0.57 (0.18–1.74)	6 % (9)	1.2 (0.43–3.25)
Chronic or disabling conditions												
Cardiovascular	0 % (0)	0	0 % (0)	0	100 % (4)	1.2 (1.13–1.26)	50 % (2)	0.84 (0.31–2.25)	0 % (0)	0	0 % (0)	–
Respiratory	23 % (6)	1.7 (0.77–3.58)	12 % (3)	0.70 (0.23–2.11)	85 % (22)	1.01 (0.85–1.19)	69 % (18)	1.2 (0.88–1.53)	8 % (2)	2.3 (0.51–10.17)	4 % (1)	0.65 (0.08–4.753)
Mental	22 % (2)	1.6 (0.45–5.64)	33 % (3)	2.02 (0.77–5.33)	78 % (7)	0.93 (0.65–1.31)	78 % (7)	1.3 (0.91–1.88)	11 % (1)	3.3 (0.46–23.59)	0 %	–
School social support												
Beneficiary	18 % (10)	1.2 (0.63–2.39)	21 % (12)	1.3 (0.73–2.43)					5 % (3)	1.2 (0.3–4.1)	5 % (3)	0.94 (0.27–3.26)

Legend: %: percentage compared to the total in each category; PR: prevalence ratio; CI (95 %): confidence Interval with 95 % confidence; –: not applicable.

The results in the section assessing conditions in the student's homes indicated that most of the students feel comfortable at home. During summer, 17 % of students reported that the temperature was uncomfortable at home, and 15 % reported the same for winter. 5.8 % of students indicated discomfort in both seasons, and 41 % reported mould or damp problems in their homes. With regard to climatization equipment in the student's homes, 8 % of students reported using no heating equipment, while 18 % reported using no cooling equipment. 3.4 % of students indicated using no equipment. The electric heater was the most frequently used heating equipment, and, for cooling purposes, most students use portable fans.

In the classroom, the levels of discomfort in the non-renovated school were higher than the ones observed in the renovated school: during summer (Fig. 2), 84 % of students were uncomfortable, and 42 % of students rated the classroom temperature as "Hot". Lower levels of discomfort were observed during winter (Fig. 3): the percentage of students uncomfortable was 61 %, with 20 % of students rating the classroom temperature as "Cold". Students perceive the classroom temperature as a crucial factor for their well-being in school: 76 % of students perceive it to affect their attention in class, and 70 % perceive it to affect their performance during exams. Regarding the type of garments usually used by students in the classroom, the most frequently used garments were jackets (with 59 % reporting using them often and 37 % reporting using them sometimes). When asked about their actions when uncomfortable in the classroom, most of the students referred to adjusting their level of clothing, 9 % of the students take no action when uncomfortable.

When asked to compare the thermal comfort levels in school and their homes, most students indicated that the temperature at home was more comfortable: 93 % were more comfortable at home during summer and 88 % were more comfortable at home during winter. The second most frequent answer was students expressing that they were uncomfortable both at school and at home, with 4.1 % identifying discomfort during the summer and 5.2 % during the winter. Nevertheless, and as observed in the sample of students from the renovated school, the number of students who indicated feeling simultaneously uncomfortable at home in the dwelling section of the survey and uncomfortable at school in the school section of the survey was higher than the number of students who selected the "uncomfortable in both places" option in this section: the percentage of students selecting the "uncomfortable" option in the two different sections was 14 % during both the summer and winter periods. The students who reported discomfort were analysed in groups in Table 4. Students from disadvantaged backgrounds were most likely to report discomfort in almost all situations studied, except during winter in the "both places" category. Girls were also more likely to report discomfort than boys, except during summer in the "both places" category.

In the open-ended question, 44 students gave their opinion regarding energy poverty and thermal comfort in schools. Among these, 20 responses pertained to the lack of climatisation systems, six responses expressed and reinforced the students' perceived discomfort in school, and 18 referred to the impact of the classroom's temperature on their well-being and/or academic performance. In the comments regarding the climatisation systems, the students expressed a preference for classrooms with air conditioning and perceptions that equipment would improve their comfort. Some students also described problems with the blinds, windows, or heaters in some classrooms. The students also detailed how the classroom temperature affects their health, well-being, and academic performance, for example: "*Last winter, I had "chilblains" on my fingers due to the very low temperatures in the classroom.*" (Female, 17 years old).

> "*I cannot breathe in classrooms during the summer*".
>
> (Male, 16 years old)

> "*The fact that the classrooms were very hot led to me having an atonic seizure*".
>
> (Female, 16 years old)

Only one student directly mentioned the impact of poor dwelling quality at home on her comfort levels, indicating discomfort at home and school. This statement suggests that some students may experience a persistent lack of thermal comfort:

> "*It is terrible to be in the winter at school in a horrible freeze, and the heater either does not turn on or, if it does, it does not reach everyone, only those who are near it! At home, the nights are the most complicated and often prevent me from sleeping because it is either very cold and I cannot even keep warm with many blankets and several layers on, or it is so hot that even leaving the window half open to receive the night air does not help me from sweating.*"
>
> (Female, 18 years old)

There were 13 responses to the teacher's survey. Regarding thermal comfort in the classroom, the summer results indicated that 76 % of the teachers felt discomfort during summer and 85 % felt discomfort during winter. Most teachers (92 %) indicated that they allow their students to operate the windows.

5. Discussion

5.1. Energy poverty at home

The two schools reported similar responses to the questions in the energy poverty section of the survey. During summer, 15 % (NRS) and 21 % (RS) considered that their house was not comfortable, and 17 % (NRS) and 19 % (RS) perceived discomfort during winter. The use of heating equipment was higher in students from the NRS, but these students use less cooling equipment than those from the RS. These differences highlight the importance of studying energy poverty at the local level, as, despite being in close regions, the students reported slightly different levels in these indicators.

It is not obvious why students from the renovated school reported higher levels of discomfort. It was initially expected that the opposite would occur as the buildings in the NRS municipality had a lower energy performance (according to the energy performance certificate system) [18] and had a higher vulnerability to energy poverty in the EPVI [53]. Nevertheless, the RS municipality has a higher unemployment rate, and the temperatures are slightly higher, which may explain why these students reported more discomfort at home. The fact that the heating season has a longer duration in the non-renovated school may be related to the fact that these students reported more discomfort at home during winter. Conversely, the renovated school is in the V_3 summer climatic zone, a region with higher temperatures, which explains why these students reported more discomfort at home during summer.

The results obtained for the thermal comfort at home during winter were similar to the ones obtained in the "Inability to keep house adequately warm" at the national level [9]. Nevertheless, the results were much lower than those obtained for Lisbon municipality by the local energy agency (42 % of respondents could not keep their homes warm during summer and 32 % during winter) [58]. They were also lower than those obtained by Castro & Gouveia [39], where 66 % of local Portuguese students and 77 % of exchange students studying in Portugal experienced discomfort during winter. Similarly, 51 % of local Portuguese students and 54 % of exchange students in Portugal expressed discomfort during summer [39]. Direct comparison of the indicator "Population living in dwelling with presence of leak, damp and rot" with the percentage of students reporting having problems with dampness and mould in their dwellings, shows that the levels reported were higher in the student population, as in 2020, 25.2 % of the Portuguese population were reporting it [9]. Regarding the ownership of climatization equipment in the students' homes, 10 % of students reported not having heating equipment, 17 % reported having no cooling equipment, and 3.8 % did not have any equipment. These numbers differ from the ones obtained at the Survey on Energy Consumption in Households (18.4 % do not have equipment for heating and 67.3 % do not have equipment for cooling) [59], but the trend of lower cooling equipment ownership is still observed. Most of the students who indicated discomfort in the home have cooling or heating devices, suggesting that the discomfort may be attributed to a lack of building envelope insulation or that the climatization equipment is present in one division of the dwelling. Less efficient equipment was reported in a higher number of students from low-income households. 38 % of students whose families that did not receive school social support indicated having air conditioning while 21 % of the students whose families receive this type of support reported having this type of equipment. 55 % of supported students use electric heaters compared to 46 % of those without support. Regarding cooling, 66 % of supported students use fans, compared with 50 % of unsupported students.

Taking these results into account, the student survey results show that energy poverty is an issue related to gender and health, as also demonstrated in studies focused on younger and older populations. With regard to thermal comfort in the home, the students who identified as female had between a 1.3 and 1.9 times higher chance of reporting discomfort at home than those who identified as male, depending on the season and group. The same phenomenon was observed in students who reported a chronic condition or disability and those from disadvantaged backgrounds.

5.2. Thermal comfort at school

The students from the two schools exhibited disparate levels of discomfort, as expected, given the variations in the construction characteristics of the respective buildings. The school that had not undergone renovation, characterised by simple-glazed windows and malfunctioning blinds, reported higher discomfort levels than the renovated school. However, even in the renovated school, the observed level of discomfort exceeded expectations. It was anticipated that after renovation, the level of discomfort would align closely with the thermal comfort standards, with an anticipated value of around 10 %. However, higher values were observed. This high level of discomfort can be attributed to multiple factors related to the renovation project or the perception of students, and it is challenging to attribute it to a single explanation. One possible explanation is that, as the school was recently renovated, the students may still be adjusting to the new school and are still adjusting to its new layout and features. On the same logic, before the renovation, the students may have anticipated a significant improvement in their comfort and as the renovation did not follow their expectations, they may still be perceiving discomfort. Other contributing factors may be malfunctioning climatisation equipment in some classrooms, the potentially restricted use of climatisation systems or inadequate knowledge of how to properly operate them by teachers and school staff. These last assumptions are supported by the fact that 4.8 % of students classified the temperature as "hot" or "warm" during winter and by the comments left by the students in the open-ended section of the survey.

Additionally, the design of the windows can influence discomfort levels. In the RS classrooms, the windows were large and heavy, and only a small portion are operable. This can lead to limited natural ventilation and accumulated stagnant classroom air thereby contributing to students' discomfort (which was also stated by Lourenço et al. [60]). Variations in the location of classrooms may also contribute to different levels of discomfort, as specific classrooms receive varying degrees of sunlight exposure.

The percentage of students who reported feeling uncomfortable was higher than that observed in Portuguese schools by Pereira et al. [44] or Saraiva et al. [45]. Nevertheless, this last study cannot be directly compared as different methodologies were applied. Looking into other thermal comfort studies in schools in other Mediterranean countries, the values obtained in the Portuguese NRS schools were higher than the ones obtained in Italy [46], Cyprus [47], and Greece [48]. Students reporting less discomfort in the classroom during winter may be related to the fact that students prefer cooler environments, a tendency which was also reported by several thermal comfort studies in schools [43]. Between the two schools, on average, 9 % of the surveyed students reported not doing anything when they felt uncomfortable, uncovering an important consideration for teachers and other educational stakeholders. This number was lower than those obtained in other studies; for example, Kim & De Dear [61] reported that 31.3 % of students do not act when they feel uncomfortable. The disparities in comfort levels between the two schools were further evidenced through the frequency of garment usage. Students attending the non-renovated school reported a higher frequency of utilizing blankets, jackets, scarves, and paper fans than those from the renovated school. In both schools the level of discomfort was higher during summer than in winter, reinforcing the need for strategies to improve thermal comfort during this season.

It is important to note that, while the survey questions referred to the whole year, the fact that the survey was conducted mid-season may have led to underestimations of thermal discomfort on the part of the students, and higher levels of discomfort may be observed if a similar survey were held during the winter or summer seasons. This is because the current temperature of the classroom may influence the students' perceptions.

5.3. Impact of renovation on thermal comfort

Analysis of the results from the final section of the survey reveals several noteworthy observations. Students from the non-renovated school experienced more discomfort during winter. In contrast, students from the renovated school faced more discomfort during summer, a trend also observed in the energy poverty section. Regarding the students who reported feeling uncomfortable during summer, the students from the NRS were 1.62 times (CI 95 %: 1.5–1.8) more likely to report being uncomfortable at school than the ones from the renovated school. During winter, this frequency was 1.56 times higher (CI 95 %: 1.3–1.8). Furthermore, the number of students who indicated feeling more comfortable at school added to the number of students who indicated feeling comfortable in both places was three times higher (CI 95 %: 1.8–4.9) in the renovated school during winter and almost eight times higher (CI 95 %: 3.8–17.3) during summer. However, the higher-than-expected discomfort in the renovated school should also be considered, and some possible explanations have already been suggested in Section 5.2. One of the key findings of this study is that schools that provide thermal comfort conditions may serve as a refuge for students experiencing energy poverty at home, thereby mitigating its negative impacts.

5.4. Teachers' survey results

The findings from the teachers' surveys complement the students' responses and provide valuable insights into the students' relationship with the classroom environment. Notable differences emerged between the two schools: in the renovated school, teachers reported significantly lower levels of discomfort compared to the students, whereas in the non-renovated school, the results were more closely aligned. This discrepancy may be attributed to the fact that the climatisation system in the renovated school is not being properly used (as addressed in Section 5.2), or it might be tailored to the teachers' preferences rather than the students', resulting in discomfort for the latter. Teachers face the dilemma of trying to regulate the temperature to suit every student's needs, often leading them to maintain a temperature they find comfortable. However, this approach might not align with the students' thermal preferences due to age and thermal sensitivity differences. Additionally, most of the teachers in the RS indicated that they do not let the students operate the air conditioning system, adding weight to these suppositions. The underuse of the climatisation system by the teachers may also be a result of social factors related to climatization system usage: even if the school directors board does not restrict the use of the system, teachers may feel that they should not use it to avoid high energy consumption in schools. Teachers' higher tolerance to thermal discomfort can also contribute to the non-use of these systems. Teachers are also usually more active in class than the students, contributing to being less cold than the students. Additionally, students spend more time in the classroom than teachers, contributing to them being more exposed to possible thermal discomfort and, therefore, being more likely to report it. Another interesting finding was that discomfort was higher during summer in the students' survey while in the teachers survey it was higher during winter, contributing to the fact that children and young people tend to prefer colder temperatures.

Nonetheless, it is crucial to interpret the results from the teachers' surveys cautiously, as the number of responses might not be statistically significant compared to the total number of teachers in each school.

5.5. Double vulnerability

Linking back to the objectives of this study, it can be affirmed that, for a portion of the upper secondary education student population surveyed, permanent thermal discomfort is a reality. In the survey section evaluating double vulnerability, on average, 8 % of students indicated discomfort at school and at home during summer and 5 % during the winter. However, it is possible that the number of students experiencing discomfort in both places may be higher. This assumption is based on the intersection of different survey sections, where the percentage of students reporting discomfort at home and at school amounts to 14 % during summer and 12 % during winter. It is difficult to attribute a single explanation to this result as several factors may have contributed to this. Considering these results more deeply, the number of students who reported feeling uncomfortable at home and at school individually stated that they were more comfortable at home in the last section of the survey. This may be attributed to several causes, including the stigma attached to energy poverty within their age group and the social perception of what a home should represent. There could be a social inclination to prioritize perceiving their home as a more comfortable place since homes are culturally expected to be safe and cosy locations (as argued by [62]). This connects with the idea that being uncomfortable at home is considered normal in Portugal [63]. Lastly, students may have reported that they were more comfortable at home due to being more familiar with their surroundings and perceptions of greater control at home. While students can control their thermal environment at home (by using HVAC equipment or easily adjusting their level of clothing) at school, their comfort expectations might be lower due to a lack of control over the environment.

Correlations emerged between reporting discomfort and the presence of a chronic illness or disability or benefiting from school social support, specifically among students reporting respiratory or mental illnesses. Therefore, considering the negative effects of poor housing conditions on pre-existing health conditions, there is a risk that if a school building fails to provide thermal comfort, existing health conditions may be exacerbated. Moreover, young individuals from disadvantaged backgrounds often encounter lower levels of stimulation and academic expectations [64]. Consequently, these undesirable effects can be further exacerbated if a school fails to provide an environment that fosters stimulation and motivation.

6. Conclusions

This work investigated how young people, aged 15 to 18, perceive energy poverty in their homes and thermal comfort at school. Over recent years, energy poverty has gained prominence on the political agenda. The literature identifies children and young people as a group vulnerable to energy poverty. In Portugal, one of the European countries with the highest energy poverty rates, vulnerability to a lack of thermal comfort manifests beyond the residential sector, as many school buildings have a poor energy performance due to their age and limited renovation activities. The findings from this study significantly add to the understanding of how young individuals perceive energy poverty and thermal comfort at home. They contribute to the limited literature available on how energy poverty specifically affects young people, emphasising the crucial role of age in thermal comfort. The conclusions show that approximately 18 % of young people experience a lack of thermal comfort in their homes, over half experience discomfort in the classroom, and 7 to 14 % suffer permanent discomfort. Despite their similarity, the differences observed between the two student samples emphasise the necessity of studying energy poverty at a micro-level. This also highlights the importance of developing targeted energy poverty alleviation strategies that reflect different regions' specific needs.

The upcoming years will be crucial in addressing this problem, with several proposed mitigatory measures aiming to reduce the impacts of the condition. Firstly, at the energy poverty level, it is imperative to target these younger age groups in energy poverty policies. Correspondingly, indicators such as "% of households with young people aged 18 and under" and "Poverty risk rate by age group (under 18)" should be incorporated into energy poverty risk mapping. Engaging young individuals in policy-making is equally vital, especially at the local level. This can be achieved by empowering them to lead youth-driven projects within their communities and listening to their experiences and insights. Furthermore, other solutions, such as providing energy subsidies to low-income families with dependents during extreme events or targeting energy efficiency financing schemes at vulnerable families could significantly contribute to alleviating the issue. Lastly, including topics related to energy efficiency and energy poverty in the school curriculum could help raise awareness of them in the student population.

Regarding thermal comfort in schools, the results provide guidelines/insights for designing more efficient renovation or rehabilitation projects for schools. While renovating older and inadequately maintained schools and implementing rigorous monitoring plans is essential, alone these measures may not be enough. These projects should include guidelines for teachers and school staff regarding the operation of climate control systems, including a specific temperature range tailored to each school's needs. The design of schools in future renovation plans should prioritize the use of passive strategies. To achieve this end, the design of windows and glazed areas should be tailored to the needs of the school's occupants, ensuring that students and staff can easily operate them. Additionally, renovated schools should also have photovoltaic panels, contributing to the use of climatisation systems without high energy prices. Considering that the level of discomfort was higher during summer and that in the future heat waves and the increase of the heat island effect will compound this effect, it is essential to develop tailored measures for the cooling season. This may involve implementing shading systems and increasing the green spaces near buildings exposed to higher levels of sunlight. Adapting school timetables to the seasons to avoid peak temperatures is another viable option.

Changing the way we view school buildings could benefit the mitigation of climate change while simultaneously addressing energy poverty. Schools can be adapted to function as climate refugees, where both the students and residents can take refuge from extreme temperatures. For instance, opening schools to communities can help alleviate the inadequate conditions experienced by some at home. By providing spaces where students can socialize and study outside of school hours, the impact of their living conditions on their development can be diminished. Schools can also operate as one-stop shops during these periods, providing guidance to families on addressing energy poverty and involving the students in this process.

This study has some inherent limitations. The first and most significant was the difficulty in involving schools in the study. Many schools were contacted, and most refused to participate or did not reply despite several invitations being issued. Secondly, the surveys were conducted mid-season when temperatures were neither too hot nor too cold. Thus, thermal comfort levels the students experienced at the time the survey was conducted might have influenced their responses, potentially impacting the survey results. Thirdly, the surveys were conducted in schools in the Lisbon region, where the climate is less extreme than in other areas of Portugal. As a result, future work should include school studies with representative samples across different regions and various types of schools (public, private, traditional, and vocational education) and throughout different seasons. This would provide a more comprehensive analysis of young people's experiences and perceptions regarding energy poverty and thermal comfort. Additionally, complementing the surveys with qualitative interviews with a section dedicated to the student's vision of the solutions to this issue would be highly pertinent. Lastly, surveys and/or interviews with the parents on these issues, discussing the results with the school board of directors, and co-construction of the results may yield insightful findings, as they may perceive the students to be comfortable, while this perception is not shared by the students.

Based on the findings of this study, it is important to emphasise that climate change and the extreme events associated with it will further intensify indoor thermal discomfort. Considering the discomfort observed during summer, climate change will exacerbate the heat island effect and students' risk of being more uncomfortable, impacting their health and academic performance. Consequently, taking decisive action to mitigate these effects is imperative, as it is critical to ensuring comfort in residential and educational settings. Looking to the future, children and young people will bear the long-term impacts of climate change. By investing today in resilient infrastructure, we are creating a safe and sustainable future where every young individual can thrive, regardless of the challenges brought by climate change.

CRediT authorship contribution statement

Inês Valente: Writing – review & editing, Writing – original draft, Visualization, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **João Pedro Gouveia:** Writing – review & editing, Validation, Supervision, Methodology, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

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Appendix A. Students' surveys

Students' surveys

Section 1: student characterisation

Q1: School Year
- 10th Grade
- 11th Grade
- 12th Grade

Q2: Age
- <15 Years Old
- 15 Years Old
- 16 Years Old
- 17 Years Old
- 18 Years Old
- >18 Years Old

Q3: Gender
- Male
- Female
- Non-binary
- Other

Q4: Do you have any chronic or disabling condition?
- No
- Yes, cardiovascular
- Yes, respiratory
- Yes, mental Illness
- Yes, other
- I prefer not to answer

Q5: School Social Support Level:
- Level A
- Level B
- Level C/I do not have School Social Support
- I prefer not to answer

Section 2: Thermal comfort at home/energy poverty

Q6: In your house, the temperature during winter Is comfortable:
- Yes.
- No.

Q7: In your house, the temperature during summer Is comfortable:
- Yes.
- No.

Q8: In your house, do you use equipment to warm it during winter:
- No.
- Yes, air conditioning
- Yes, Fireplace.
- Yes, electric heater.
- Yes, natural gas heater.
- Yes, other.

Q9: In your house, do you use equipment to cool it during summer?
- No.
- Yes, portable fan
- Sim, air conditioning

Q10: Does your house has problems related with mould or dampness:
- Yes.
- No.

Section 3: Thermal comfort at school

Q11: During summer, the temperature Inside classroom Is:
- Hot
- Warm
- Slightly Warm
- Neutral/comfortable
- Slightly cool
- Cool
- Cold

Q12: During winter, the temperature Inside classroom Is:
- Hot
- Warm
- Slightly Warm
- Neutral/comfortable
- Slightly cool
- Cool
- Cold

Q13: I consider that the temperature of the classroom affects my ability to concentrate in class.
- Yes.
- No.

Q14: I consider that the temperature in the classroom affects my academic performance:
- Yes.
- No.

Q15a: Indicate how often you use blankets in the classroom in winter:
- Never
- Rarely
- Sometimes
- Often

Q15b: Indicate how often you use scarfs in the classroom in winter:
- Never
- Rarely
- Sometimes
- Often

Q15c: Indicate how often you use jackets in the classroom in winter:
- Never
- Rarely
- Sometimes
- Often

Q16: Indicate how often you use paper fan in the classroom in summer:
- Never
- Rarely
- Sometimes
- Often

Q17: When the temperature in the classroom is not comfortable, i:
- I tell the teacher and ask to open the window or adjust the climatisation.
- I open the windows.
- I adjust the climatisation to a comfortable temperature.
- I adjust the blinds.
- I adapt my level of clothing.
- I do not do anything.

Section 4: Dual vulnerability

Q18: In the warmer months, the temperature is more comfortable:
- In school.
- In my house.
- It is uncomfortable in both.
- It is comfortable in both.

Q19: In the coldest months, the temperature is more comfortable:
- In school.
- In my house.
- It is uncomfortable in both.
- It is comfortable in both.

Open ended section

Q20: Is there any experience/opinion about thermal comfort at school and energy poverty at home that you wanted to share?

Appendix B. Teachers' survey

Teachers' survey

Thermal comfort section

Q3: Classroom climate conditions are favourable for teaching, regardless of the season.

- Yes.
- No.

Q4: During summer, the temperature Inside classroom Is:

- Hot
- Warm
- Slightly Warm
- Neutral/comfortable
- Slightly cool
- Cool
- Cold

Q5: During winter, the temperature Inside classroom Is:

- Hot
- Warm
- Slightly Warm
- Neutral/comfortable
- Slightly cool
- Cool
- Cold

Q6: Do the classrooms have heating/cooling equipment?

- Yes.
- No.
- Yes, but they are not working.

Q7: I consider that thermal discomfort can jeopardize the students' attention in classroom.

- Yes.
- No.

Q8: I consider that thermal discomfort can affect students' performance during tests.

- Yes.
- No.

Q9: I consider that thermal discomfort affects my performance as a teacher.

- Yes.
- No.

Q10: The student has the freedom to open the classroom windows.

- Yes.
- No.

Q11: The student has the freedom to use the heating/cooling equipment in the classroom.

- Yes.
- No.

Q12a: Indicate how often you use blankets in the classroom in winter:

- Never
- Rarely
- Sometimes
- Often

Q12b: Indicate how often you use scarfs in the classroom in winter:

- Never
- Rarely
- Sometimes
- Often

Q12c: Indicate how often you use jackets in the classroom in winter:

- Never
- Rarely
- Sometimes
- Often

Q13: What heating equipment is available in classrooms?

- Air Conditioning
- Central heating
- Electric heater
- Natural gas heater
- Other
- It only has cooling equipment.

Q14: What cooling equipment is available in classrooms?

- Portable Fans
- Air conditioning
- It only has heating equipment.

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