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Urban housing conditions and indoor environmental inequalities: a socio-environmental analysis of sanitation, ventilation, and health-related risks in residential apartments in Durrës, Albania

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Abstract

This study examines urban housing conditions and indoor environmental inequalities in residential apartments in Durrës, Albania, with a focus on sanitation, ventilation, and housing-related health risks. Using a cross-sectional design, data were collected from 150 households through structured questionnaires and direct observations, covering housing characteristics, household behaviors, and indicators of indoor environmental quality, including moisture, mold, pests, and ventilation practices. The results reveal generally positive self-reported hygiene conditions and housing satisfaction; however, objective environmental assessments indicate persistent risks, particularly moisture (26%) and mold (22%) presence, as well as widespread insect infestation (49.3%). Statistical analyses show that indoor environmental conditions are significantly associated with structural housing factors, including pipe leakage, ventilation practices, heating systems, and household composition, while behavioral factors alone are insufficient to explain environmental risks. A notable discrepancy was identified between residents' perceptions of housing quality and measured environmental conditions, suggesting limited awareness of indoor environmental health risks. The findings highlight that indoor environmental quality is shaped primarily by structural housing conditions rather than individual behaviors alone, reflecting broader patterns of urban housing inequality. From a social determinant of health perspective, the study emphasizes the role of housing infrastructure and environmental conditions in shaping health vulnerability. The results underscore the need for integrated housing and public health policies focused on building

maintenance, ventilation standards, and environmental health literacy to reduce preventable risks and promote equitable urban living conditions.

Keywords: social determinants of health; environmental justice; public health vulnerability; sanitation practices; indoor environmental exposure; residential well-being; urban governance; social inequality

1. Introduction

Housing conditions, including hygiene, sanitation, and indoor environmental quality, are increasingly recognized as important social determinants of health and well-being (WHO, 2018). In urban societies, housing represents both a physical and social environment influencing quality of life, health equity, and social inclusion. Because people spend most of their time indoors, particularly in residential settings, housing quality significantly affects physical and mental health outcomes (European Commission, 2017). Poor housing conditions have been associated with respiratory diseases, allergic disorders, cardiovascular problems, psychological stress, and reduced quality of life, especially among socioeconomically vulnerable populations, reflecting broader patterns of urban inequality and environmental injustice (Thomson et al., 2013).

Rapid urbanization and uneven urban development have intensified concerns regarding healthy housing environments. Literature in public health and social sciences emphasizes that inadequate housing conditions are closely linked to socio-economic inequalities, limited public services, and weaknesses in urban planning and housing governance (Krieger & Higgins, 2021). Environmental justice perspectives further highlight how disadvantaged populations are disproportionately exposed to poor sanitation, overcrowding, and indoor pollution.

Among indoor environmental hazards, dampness and mold growth are major public health concerns associated with inadequate ventilation, water leakage, condensation, and poor building maintenance (Mendell et al., 2011). Exposure to damp and mold-contaminated environments has been linked to asthma, chronic respiratory symptoms, and respiratory infections (Fisk et al., 2007; Quansah et al., 2012). The World Health Organization also identifies indoor dampness and mold as significant environmental health risks requiring preventive housing policies and interventions (WHO, 2009).

Adequate ventilation, safe water supply, and effective sanitation systems are essential components of healthy residential environments. Poor ventilation may increase indoor pollutants and humidity, while inadequate sanitation infrastructure contributes to infectious disease transmission and pest infestations (Sundell et al., 2011; Prüss-Ustün et al., 2019). Household practices such as cleaning behaviors, heating methods, and indoor smoking also influence indoor environmental quality and health outcomes (Jacobs, 2011; Madureira et al., 2020). Recent evidence

additionally highlights interactions between energy efficiency measures and indoor environmental risks, including increased dampness in poorly ventilated homes (Sharpe et al., 2021; Salonen et al., 2021; Logue et al., 2020).

Previous studies have often focused on general housing quality or specific health outcomes, while comprehensive assessments of sanitation and hygiene conditions at household level remain limited. Urban areas characterized by aging infrastructure and unequal access to services continue to face important environmental and public health challenges (Bonnefoy et al., 2021; Langer et al., 2021). The COVID-19 pandemic further emphasized the importance of healthy housing environments within broader social determinants of health and urban resilience frameworks (Krieger & Higgins, 2021; Rollston & Galea, 2020).

In Albania, studies have increasingly examined relationships between urban environments, sustainability, and public health outcomes. Research in Durrës has highlighted environmental pressures associated with urban development and tourism (Gashi et al., 2026), while epidemiological evidence has linked chronic diseases with urban living conditions (Haxhihyseni et al., 2025). Advanced statistical approaches, including SPSS-based factor reduction techniques, have also been increasingly applied in Albanian research contexts (Kosova et al., 2025). However, evidence examining sanitation, indoor environmental quality, and housing-related health risks in Albanian residential apartments remains limited.

Therefore, this study aims to assess hygiene, sanitation, and indoor environmental conditions in residential apartments in Durrës and to identify housing-related factors associated with moisture and mold that may influence residents' health outcomes. The study also contributes to discussions on urban health inequalities, residential well-being, and housing conditions as social determinants of health in rapidly developing urban contexts.

2. Methods

2.1 Study Design

This study employed a quantitative cross-sectional observational design within a socio-environmental research framework to examine the relationship between housing conditions, sanitation, and indoor environmental quality in residential apartments in Durrës, Albania. The design allowed for the assessment of both physical housing characteristics and household practices as social and environmental determinants of residential well-being at a single point in time, as well as the analysis of associations between these conditions and key indicators of indoor environmental risk, including moisture and mold.

2.2 Study Setting and Population

The study was conducted in the urban area of Durrës, Albania, a rapidly developing coastal city characterized by high residential density, diverse socio-economic

conditions, and varying levels of housing quality. From a social science perspective, the urban context reflects broader patterns of infrastructure development, residential stratification, and unequal access to housing quality. The study population consisted of households living in apartment dwellings within the city. Eligible respondents were adult household members (≥ 18 years) with sufficient knowledge of housing conditions and daily domestic practices.

2.3 Sampling Strategy and Sample Size

A total of 150 households were selected using a stratified random sampling approach. Stratification was based on residential building characteristics in order to ensure variability across different types of apartment structures and housing conditions. This approach was used to capture heterogeneity in both environmental exposure and living conditions, reflecting the diversity of urban residential settings. The sample size was considered sufficient for both descriptive analysis and inferential statistical testing of key housing and environmental variables.

2.4 Inclusion and Exclusion Criteria

Inclusion criteria were: (i) adults aged 18 years or older; (ii) residence in the selected dwelling for at least six months; and (iii) informed consent to participate in the study. Households were excluded if questionnaire responses were incomplete or inconsistent, if the dwelling was unoccupied at the time of data collection, or if participants declined or withdrew consent. These criteria ensured data quality and reliability of reported housing and environmental conditions.

2.5 Data Collection Instruments and Procedures

Data were collected using a structured questionnaire combined with a standardized observational checklist. The questionnaire captured sociodemographic characteristics, household composition, housing structure, ventilation and heating practices, indoor smoking behavior, water supply and sanitation systems, cleaning and hygiene practices, and pest control measures. These variables were selected to reflect both material housing conditions and household behaviors that shape indoor environmental quality.

In addition, direct on-site observations were conducted to assess ventilation functionality, natural lighting, visible moisture, mold presence, and indicators of pest infestation. Data collection was carried out by trained field investigators following standardized protocols to ensure consistency, reduce measurement bias, and improve comparability across households.

2.6 Validity and Reliability

The study instrument was developed based on established international literature and guidelines on housing quality and indoor environmental health, reflecting widely used indicators in socio-environmental research. Content validity was ensured

through expert review in environmental health and public health, which improved clarity, relevance, and conceptual alignment of the instrument with study objectives.

To enhance reliability, the questionnaire was pre-tested in a pilot sample of households prior to the main data collection. Feedback from the pilot study was used to refine wording, improve comprehension, and reduce ambiguity. Furthermore, standardized training of field investigators and the use of structured observation tools contributed to improving inter-observer consistency and reducing potential measurement bias.

2.7 Data Analysis

Data were coded, cleaned, and analyzed using IBM SPSS Statistics version 25 (IBM Corp., Armonk, NY, USA). Descriptive statistics (frequencies, percentages, means, and standard deviations) were used to summarize household and housing characteristics within a socio-environmental framework. Associations between housing conditions and environmental indicators such as moisture and mold were assessed using chi-square tests. Statistical significance was defined as $p < 0.05$.

Given the cross-sectional design, the study identifies statistical associations between housing conditions and environmental health risks but does not allow for causal inference. The interpretation of findings is therefore framed within a socio-environmental and public health inequality perspective, emphasizing patterns of exposure rather than causal pathways.

3. Results

3.1 Socio-demographic characteristics of households

The socio-demographic profile of the surveyed households reflects a typical urban residential structure with moderate household size and multigenerational composition (Table 1). The average household size was 3.87 ± 1.44 individuals, ranging from 1 to 8 members.

Most households consisted of 3–5 members (67.4%), while 21.3% included 1–2 persons and 9.3% had six or more members. Regarding household composition, 55.3% of households included at least one child under 15 years, whereas 44.7% reported no children. In addition, 40.7% of households included at least one older adult (≥ 65 years), indicating the presence of potentially vulnerable groups within the residential environment.

Chronic illness was reported in 14% of households, suggesting underlying health vulnerabilities that may interact with housing and environmental conditions. Overall, the findings indicate variability in household structure and potential differences in exposure to environmental risks and residential well-being.

Table 1. Socio-demographic and household composition characteristics of residents in urban apartments in Durrës, Albania (n = 150).

Variable	Category	Frequency (n)	Percentage (%)
Number of people living in the apartment	1 person	2	1.3
	2 people	30	20
	3 people	23	15.3
	4 people	48	32
	5 people	31	20.7
	6 people	9	6
	8 people	5	3.3
	Not applicable	2	1.3
	Mean $\pm$ SD	3.87 $\pm$ 1.44	
	Range	1–8	
Home location	Durrës (urban area)	150	100
Number of children (<15 years)	1 child	40	26.7
	2 children	31	20.7
	3 children	12	8
	No children	67	44.7
Number of elderly (≥ 65 years)	1 elderly	34	22.7
	2 elderly	20	13.3
	3 elderly	7	4.7
	No elderly	89	59.3
Chronic illness in household	Yes	21	14
	No	129	86

3.2 Housing characteristics of residential apartments

The analysis of housing characteristics showed that 54.7% of respondents lived in apartment buildings, while 43.3% resided in private houses (Table 2). Most dwellings consisted of 2–3 rooms (54%), whereas 36% had only 1–2 rooms, indicating limited residential space in part of the sample.

Functional windows and sufficient natural lighting were reported in 97.3% of dwellings, suggesting generally adequate structural housing conditions. However, smaller dwelling size may still influence indoor environmental quality and residential comfort in some households.

Table 2. Housing characteristics of residential dwellings in Durrës, Albania (n = 150).

Variable	Category	Frequency (n)	Percentage (%)
Type of dwelling	Private house	65	43.3
	Apartment	82	54.7
	Normal building	0	0
	Not applicable	3	2
Number of rooms in the apartment	1 room	20	13.3
	2 rooms	34	22.7
	3 rooms	47	31.3
	4 rooms	26	17.3
	5 rooms	13	8.7
	7 rooms	8	5.3
	8 rooms	2	1.3
Functional windows in rooms	Yes	146	97.3
	No	4	2.7
Sufficient natural lighting during the day	Yes	146	97.3
	No	4	2.7

3.3 Ventilation characteristics of residential dwellings

Most households (93.3%) reported regularly ventilating their apartments, while 6.7% indicated insufficient or irregular ventilation (Table 3). In contrast, only 24.7% of households reported having mechanical ventilation systems, whereas 62.7% did not have such infrastructure.

These findings suggest that ventilation in most dwellings relies primarily on natural air exchange rather than mechanical systems. Limited availability of mechanical ventilation may influence indoor environmental quality, particularly in densely occupied or structurally constrained residential settings.

Table 3. Household ventilation practices and availability of mechanical ventilation systems in urban residential apartments, Durrës, Albania (n = 150).

Variable	Category	Frequency (n)	Percentage (%)
Apartment is regularly ventilated	Yes	140	93.3
	No	10	6.7
Mechanical ventilation system present	Yes	37	24.7
	No	94	62.7
	Not applicable	19	12.6
Frequency of room ventilation per day	1 time	16	10.7
	2 times	24	16
	More than 2 times	110	73.3
	Never	0	0

3.4 Moisture and mold conditions in residential environments

Moisture on walls or ceilings was reported in 26% of households, while visible mold was identified in 22% of dwellings, indicating the presence of indoor environmental problems in part of the sample (Table 4). Mold was most frequently reported in bathrooms (5.3%), followed by bedrooms (3.3%) and kitchens (2%), although most households reported no visible mold (69.3%).

The reported mold surface area ranged from small localized spots to larger affected areas, and in some households, mold had been present for more than one year. Only 22% of respondents reported taking remedial actions, mainly repainting or using antifungal cleaning products, whereas most households reported no intervention.

These findings suggest persistent moisture and mold problems in a proportion of urban dwellings, potentially reflecting differences in housing maintenance and residential environmental conditions.

Table 4. Household exposure to moisture, mold, and related remediation practices in urban residential apartments, Durrës, Albania (n = 150).

Variable	Category	Frequency (n)	Percentage (%)
Moisture on walls or ceiling	Yes	39	26
	No	109	72.7
	Not applicable	2	1.3
Mold in the apartment	Yes	33	22
	No	104	69.3
	Not applicable	13	8.7

Mold location	Bedroom	5	3.3
	Bathroom	8	5.3
	Kitchen	3	2
	Ceiling	0	0
	Bedroom + Bathroom	11	7.3
	Bedroom + Bathroom + Kitchen	3	2
	Bedroom + Bathroom + Ceiling	2	1.3
	No mold	4	2.7
	Bedroom (single location)	114	76
Visible mold surface area	0.5 m ²	6	4
	1 m ²	8	5.3
	2 m ²	3	2
	20 m ²	4	2.7
	Small surface area (unspecified)	12	8
	No mold	117	78
Time when mold was first noticed	< 6 months	7	4.7
	6–12 months	3	2
	> 1 year	24	16
	No mold	112	74.7
	Not applicable	4	2.7
Mold removal measures taken	Yes	33	22
	No	9	6
	Not applicable	108	72
Type of measures taken	Repainted the house	11	7.3
	Used antifungal cleaning products	21	14
	Not applicable	118	78.7

3.5 Cleaning practices and household hygiene conditions

Most households reported daily cleaning practices (78%), while 22% cleaned their apartments 2–3 times per week (Table 5). The use of disinfectants during cleaning was highly prevalent, reported by 92.7% of respondents.

Despite frequent cleaning practices, 49.3% of households reported the presence of insects, whereas rodent presence was rarely reported (2%). In addition, only 33.3% of households reported formal household disinfection within the previous 12 months, while most respondents reported no such activity.

These findings suggest that routine household cleaning practices are common; however, environmental conditions associated with pest exposure and sanitation challenges remain present in part of the residential sample.

Table 5. Household hygiene practices, cleaning behaviors, and pest exposure in urban residential apartments, Durrës, Albania (n = 150).

Variable	Category	Frequency (n)	Percentage (%)
Frequency of cleaning the apartment	Every day	117	78
	2–3 times per week	33	22
	Rarely	0	0
Use of disinfectants during cleaning	Yes	139	92.7
	No	8	5.3
	Not applicable	3	2
Presence of insects in the dwelling	Yes	74	49.3
	No	76	50.7
Presence of rodents in the dwelling	Yes	0	0
	No	147	98
	Not applicable	3	2
Disinfection in last 12 months	Yes	50	33.3
	No	92	61.3
	Not applicable	8	5.3

3.6 Water supply and sanitation infrastructure

Approximately half of households (51.3%) relied on the municipal water supply system, while others reported using water tanks (20.7%), wells (5.3%), or other sources (20%) (Table 6). Continuous water supply throughout the day was reported by 80.7% of respondents, whereas 19.3% experienced intermittent access.

Leakage from pipes was reported in 2% of households, while 16.7% reported odors or blockages in the sewer system, indicating the presence of some sanitation-related infrastructural problems.

These findings suggest variability in access to water and sanitation infrastructure across urban households, with a proportion of residents experiencing limitations in water supply and wastewater management conditions.

Table 6. Access to water supply and sanitation infrastructure in urban residential apartments, Durrës, Albania (n = 150).

Source of drinking water	Frequency (n)	Percentage (%)
Water Supply	77	51.3
Well	8	5.3
Water Tanks	31	20.7
Other	30	20.0
Not applicable	4	2.7
<i>Total</i>	<i>150</i>	<i>100.0</i>
Water supply ensured throughout the day	Frequency (n)	Percentage (%)
Yes	121	80.7
No	29	19.3
<i>Total</i>	<i>150</i>	<i>100.0</i>
Leakage from pipes	Frequency (n)	Percentage (%)
Yes	3	2.0
No	147	98.0
<i>Total</i>	<i>150</i>	<i>100.0</i>
Smells or blockages from the sewer system	Frequency (n)	Percentage (%)
Yes	25	16.7
No	125	83.3
<i>Total</i>	<i>150</i>	<i>100.0</i>

3.7 Heating systems and indoor combustion-related practices

Electric heating was the most commonly reported heating method, used by 74.7% of households (Table 7). Wood or gas stoves were reported by 20% of respondents, while only 4% used centralized heating systems. A small proportion of households (1.3%) reported having no heating system.

Most households (82%) reported ventilating indoor spaces during heating use, whereas 14.7% did not report such practices. In addition, 40.7% of households reported the use of gas appliances inside the home.

These findings indicate variability in household heating practices and indoor combustion-related exposures, which may influence indoor environmental quality across residential settings.

Table 7. Household heating systems and indoor combustion-related behaviors in urban residential apartments, Durrës, Albania (n = 150).

Variable	Category	Frequency (n)	Percentage (%)
Type of heating used in winter	Wood/Gas stove	30	20
	Electric	112	74.7
	Central system	6	4
	None	2	1.3
Ventilation while using stove/heater	Yes	123	82
	No	22	14.7
	Not applicable	5	3.3
Use of any gas appliance inside the home	Yes	61	40.7
	No	84	56
	Not applicable	5	3.3

3.8 Indoor smoking behavior

Indoor smoking was reported by only 2% of households, while 93.3% reported no smoking inside the home (Table 8). A small proportion of responses (4.7%) were categorized as not applicable.

These findings indicate a low prevalence of tobacco-related indoor exposure within the studied residential settings. However, indoor environmental quality may still be influenced by other factors, including heating practices, ventilation conditions, and housing characteristics.

Table 8. Household indoor smoking practices in urban residential apartments, Durrës, Albania (n = 150).

Variable	Category	Frequency (n)	Percentage (%)
Smoking inside the home	Yes	3	2
	No	140	93.3
	Not applicable	7	4.7

3.9 Self-reported housing conditions and perceived health outcomes

Most respondents rated their housing hygiene and sanitation conditions as “very good” (85.3%), while 14.7% reported them as “good” (Table 9). No respondents rated their housing conditions as average, poor, or very poor.

In addition, none of the respondents reported health problems directly associated with housing conditions. However, these findings should be considered alongside the environmental conditions identified in previous analyses, including moisture, mold, pest exposure, and infrastructural limitations reported in part of the sample.

These results suggest possible differences between perceived housing quality and objectively reported environmental conditions within the studied residential settings.

Table 9. Perceived housing hygiene conditions and self-reported housing-related health problems in urban residential apartments, Durrës, Albania (n = 150).

Variable	Category	Frequency (n)	Percentage (%)
Assessment of hygienic and sanitary condition of the dwelling	Very good	128	85.3
	Good	22	14.7
	Average	0	0
	Poor	0	0
	Very poor	0	0
Health problems related to housing conditions	Yes	0	0
	No	150	100

3.10 Association between moisture presence and housing-related factors

Most housing and household factors, including regular ventilation, household size, functional windows, heating type, and use of gas appliances, were not significantly associated with moisture presence ($p > 0.05$) (Table 10).

Statistically significant associations were observed between moisture presence and chronic illness in the household ($\chi^2 = 19.661$, $p < 0.001$), as well as pipe leakage ($\chi^2 = 8.713$, $p = 0.013$). These findings suggest that indoor moisture is more closely related to infrastructural and health-related vulnerabilities than to routine household practices.

Overall, the results indicate that structural housing conditions may play an important role in indoor environmental quality and residential health risks.

Table 10. Associations between indoor moisture and selected housing, household, and infrastructural factors in urban residential apartments, Durrës, Albania (n = 150).

Variable	Category	Moisture: Yes (n)	Moisture: No (n)	Not applicable (n)	Total	χ^2	p- value
Apartment is regularly ventilated	Yes	36	102	2	140	0.219	0.896
	No	3	7	0	10		
Number of people living in the apartment	1 person	0	2	0	2	15.152	0.368
	2 people	5	25	0	30		
	3 people	8	15	0	23		
	4 people	13	33	2	48		
	5 people	8	23	0	31		
	6 people	3	6	0	9		
	8 people	0	5	0	5		
	Not applicable	2	0	0	2		
Functional windows in rooms	Yes	39	105	2	146	1.546	0.462
	No	0	4	0	4		
Chronic illness in household	Yes	10	9	2	21	19.661	<0.001
	No	29	100	0	129		
Leakage from pipes	Yes	3	0	0	3	8.713	0.013
	No	36	109	2	147		
Type of heating in winter	Wood/Gas stove	14	16	0	30	10.796	0.095
	Electric	25	85	2	112		
	Central system	0	6	0	6		
	None	0	2	0	2		
Gas appliance	Yes	20	43	0	63	6.417	0.17
	No	17	65	2	84		

inside home	Not applicable	2	1	0	3		
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3.11 Association between indoor mold and housing-related factors

No statistically significant associations were observed between indoor mold presence and chronic illness in the household or the presence of mechanical ventilation systems ($p > 0.05$) (Table 11).

Significant associations were identified between mold presence and living room ventilation frequency ($\chi^2 = 75.468$, $p < 0.001$), pipe leakage ($\chi^2 = 10.853$, $p = 0.004$), and type of heating system used during winter ($\chi^2 = 16.49$, $p = 0.011$). These findings suggest that both ventilation practices and structural housing conditions may influence indoor mold occurrence.

Overall, the results indicate that indoor mold is associated with a combination of behavioral and infrastructural factors within the residential environment.

Table 11. Associations between indoor mold presence and housing conditions, ventilation practices, and household behaviors in urban residential apartments, Durrës, Albania (n = 150).

Variable	Category	Mold: Yes (n)	Mold: No (n)	Not applicable (n)	Total	χ^2	p- value
Household members with chronic illnesses	Yes	7	14	0	21	3.567	0.168
	No	26	90	13	129		
Mechanical ventilation present	Yes	8	23	6	37	5.543	0.236
	No	22	65	7	94		
	(Additional category as recorded)	3	16	0	19		
Living room ventilation frequency	1 time/day	3	13	0	16	75.468	<0.001
	2 times/day	4	7	13	24		
	>2 times/day	26	84	0	110		
	Yes	3	0	0	3	10.853	0.004

Leakage from pipes	No	30	104	13	147		
Type of heating in winter	Wood/Gas stove	14	13	3	30	16.49	0.011
	Electric	19	83	10	112		
	Central system	0	6	0	6		
	None	0	2	0	2		

3.12 Association between chronic illness and housing-related factors

A statistically significant association was observed between the presence of mechanical ventilation systems and chronic illness in the household ($\chi^2 = 6.23$, $p = 0.044$) (Table 12). In addition, the use of disinfectants during cleaning was strongly associated with chronic illness presence ($\chi^2 = 19.858$, $p < 0.001$).

No statistically significant association was identified between indoor smoking and chronic illness ($p = 0.304$). However, the low prevalence of indoor smoking in the sample may limit interpretation of this finding.

Overall, the results suggest that chronic illness may be associated with differences in household environmental conditions and hygiene-related practices within the residential setting.

Table 12. Associations between household chronic illness and selected housing conditions, hygiene practices, and environmental exposures in urban residential apartments, Durrës, Albania (n = 150).

Variable	Category	Chronic illness: Yes (n)	Chronic illness: No (n)	Total	χ^2	p-value
Mechanical ventilation system	Yes	3	34	37	6.23	0.044
	No	18	76	94		
	Not applicable	0	19	19		
Use of disinfectants during cleaning	Yes	18	121	139	19.858	<0.001
	No	0	8	8		
	Not applicable	3	0	3		
	Yes	0	3	3	2.383	0.304
	No	19	122	141		

Smoking inside the apartment	Not applicable	2	4	6		
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3.13 Association between household size and housing-related characteristics

Household size was significantly associated with regular ventilation practices ($\chi^2 = 54.608$, $p < 0.001$), living room ventilation frequency ($\chi^2 = 36.599$, $p = 0.001$), and cleaning frequency ($\chi^2 = 25.177$, $p = 0.001$) (Table 13). Significant associations were also observed between household size and perceived housing hygiene conditions ($\chi^2 = 38.018$, $p < 0.001$).

A strong association was identified between household size and number of rooms in the dwelling ($\chi^2 = 210.486$, $p < 0.001$), indicating a structural relationship between family size and housing capacity.

These findings suggest that household composition is associated with both housing characteristics and daily environmental practices within the residential setting.

Table 13. Associations between household size and housing conditions, ventilation practices, hygiene behaviors, and dwelling characteristics in urban residential apartments, Durrës, Albania (n = 150).

Variable	Category	1 person	2 people	3 people	4 people	5 people	6 people	8 people	Not applicable	Total	χ^2	p-value
Apartment regularly ventilated	Yes	0	30	23	48	23	9	5	2	140	54.608	<0.001
	No	2	0	0	0	8	0	0	0	10		
Living room ventilation (early in the day)	1 time	0	3	7	6	0	0	0	0	16	36.599	0.001
	2 times	2	3	0	11	8	0	0	0	24		
	>2 times	0	24	16	31	23	9	5	2	110		
Cleaning frequency	Every day	0	17	16	39	29	9	5	2	117	25.177	0.001
	2–3 times	2	13	7	9	2	0	0	0	33		

	/week											
Assessment of hygiene conditions	Very good	0	25	18	48	23	9	5	0	128	38.018	<0.001
	Good	2	5	5	0	8	0	0	2	22		
Number of rooms in dwelling	1 room	2	3	3	4	8	0	0	0	20	210.486	<0.001
	2 rooms	0	14	8	12	0	0	0	0	34		
	3 rooms	0	10	3	25	7	2	0	0	47		
	4 rooms	0	0	4	7	11	4	0	0	26		
	5 rooms	0	0	5	0	3	3	0	2	13		
	7 rooms	0	3	1	0	0	0	5	0	8		
	8 rooms	0	0	0	0	2	0	0	0	2		

3.14 Association between insect presence and household hygiene-related factors

No statistically significant association was observed between cleaning frequency and insect presence ($\chi^2 = 1.672$, $p = 0.196$) (Table 14). Similarly, perceived hygienic and sanitary housing conditions were not significantly associated with insect presence ($\chi^2 = 3.664$, $p = 0.056$).

These findings suggest that household cleaning practices alone may not fully explain insect presence within residential environments. Structural and environmental housing conditions may also contribute to pest exposure in urban dwellings.

Table 14. Associations between household insect presence, cleaning practices, and perceived hygiene conditions in urban residential apartments, Durrës, Albania (n = 150).

Variable	Category	Insects: Yes (n)	Insects: No (n)	Total	χ^2	p-value
Frequency of cleaning the apartment	Every day	61	56	117	1.672	0.196
	2-3 times per week	13	20	33		
Assessment of hygienic and sanitary condition	Very good	59	69	128	3.664	0.056
	Good	15	7	22		
	Average	0	0	0		
	Poor	0	0	0		
	Very poor	0	0	0		

4. Discussion

This study provides a comprehensive socio-environmental analysis of hygiene, sanitation, and indoor environmental conditions in residential apartments in Durrës, Albania. The findings reveal a dual pattern: on one hand, relatively favorable self-reported hygiene practices and housing conditions; on the other hand, persistent structural and environmental risks, including moisture, mold, and insect presence, which suggest underlying vulnerabilities in urban housing quality.

From a broader social science perspective, these results reflect the interaction between individual household behaviors and structural housing conditions. While most respondents reported regular cleaning practices, adequate lighting, and generally good housing conditions, objective indicators of indoor environmental quality suggest that behavioral factors alone are insufficient to ensure healthy housing environments. This aligns with the concept of housing as a social determinant of health, where environmental risks are shaped by structural inequalities rather than individual actions alone (WHO, 2018; Prüss-Ustün et al., 2019).

The observed prevalence of moisture and mold is consistent with European evidence identifying dampness as a widespread issue in urban residential buildings, particularly in aging or inadequately maintained housing stock (Vardoulakis et al., 2021; Shrubsole et al., 2021). The concentration of mold in bedrooms and bathrooms supports previous findings that poor ventilation and high humidity environments are key drivers of fungal growth (Madureira et al., 2020). The persistence of mold over

time further suggests delayed or insufficient remediation practices, a pattern also observed in comparable urban housing contexts (Abidin et al., 2020).

Importantly, the significant association between mold presence and ventilation frequency reinforces the role of household environmental management in mitigating indoor dampness (Salonen et al., 2021). However, the strong association between mold and pipe leakage highlights that structural building deficiencies remain a central determinant of indoor environmental quality. This finding is consistent with research emphasizing the importance of housing maintenance systems and infrastructural integrity in preventing dampness-related risks (Langer et al., 2021). Additionally, the association between mold and heating systems suggests that energy practices, particularly combustion-based heating under limited ventilation conditions, may contribute to indoor humidity and pollutant accumulation (Logue et al., 2020).

Despite widespread self-reported cleaning practices, the relatively high prevalence of insect presence indicates that hygiene behaviors alone do not adequately address environmental sanitation challenges. This supports the interpretation that pest infestation is more strongly linked to structural and infrastructural conditions than to individual cleaning behavior, consistent with findings from urban housing studies (Bonney et al., 2021). Moreover, the discrepancy between perceived housing quality and actual environmental conditions suggests limited awareness of indoor environmental risks among residents, reflecting broader gaps in environmental health literacy (Jacobs, 2011).

The observed associations between chronic illness and increased use of disinfectants and mechanical ventilation likely reflect adaptive household responses rather than causal relationships. Households with vulnerable members may adopt more intensive hygiene practices in response to perceived health risks. Similar patterns have been documented in contexts where health vulnerability influences household environmental behavior (Krieger & Higgins, 2021; Rollston & Galea, 2020). However, the lack of a significant association between chronic illness and mold presence underscores that environmental risks persist independently of household health status, reinforcing the structural nature of housing-related exposures (WHO, 2018; Prüss-Ustün et al., 2019).

Household size emerged as an important structural factor influencing ventilation practices, cleaning frequency, and perceived housing conditions. These findings are consistent with evidence indicating that household crowding and composition shape indoor environmental conditions through both behavioral adaptation and spatial constraints (Sharpe et al., 2021). Larger households may therefore experience distinct environmental pressures that require targeted housing and public health interventions.

A key finding of this study is the mismatch between subjective perceptions of housing quality and objectively observed environmental risks. While most respondents rated

their housing conditions as good or very good, objective indicators revealed substantial exposure to moisture, mold, and pests. This discrepancy highlights a critical gap in environmental health awareness and suggests that housing-related risks may be underrecognized at the household level. Such misalignment between perception and reality has important implications for public health interventions, as risk awareness is a prerequisite for behavioral change and prevention (Bonnefoy et al., 2021; Jacobs, 2011).

From a policy perspective, the findings underscore the need for integrated housing and public health strategies in Albania. Improving building maintenance systems, addressing pipe leakage, and enforcing ventilation standards are essential measures for reducing indoor environmental risks. Strengthening housing inspection systems and establishing minimum indoor environmental quality standards would contribute to more equitable housing conditions (WHO, 2018; Prüss-Ustün et al., 2019).

In addition, the results highlight the importance of enhancing environmental health literacy among residents and professionals. The observed gap between perceived and actual housing conditions indicates a need for educational interventions aimed at improving awareness of dampness, mold, and ventilation-related health risks. Public health campaigns and targeted training programs could support early identification and prevention of housing-related environmental hazards (Bonnefoy et al., 2021; Jacobs, 2011).

This study is limited by its cross-sectional design, which prevents causal inference, and by reliance on self-reported data, which may introduce reporting and perception bias. Future research should incorporate longitudinal designs and objective environmental measurements to further clarify causal pathways between housing conditions and health outcomes.

5. Conclusions

This study demonstrates that, despite generally satisfactory self-reported hygiene and sanitation conditions in residential apartments in Durrës, important indoor environmental health risks persist. Moisture, mold, and insect presence remain common and are primarily associated with structural housing deficiencies, particularly inadequate ventilation, pipe leakage, and specific heating practices, including the use of gas-based appliances. These findings highlight that indoor environmental quality is shaped not only by household behaviors but, more importantly, by underlying housing infrastructure and building conditions.

From a social science and public health perspective, the results emphasize that housing-related health risks are embedded within broader structural and urban conditions. The coexistence of relatively positive perceptions of housing quality with objectively measured environmental risks suggests a disconnect between lived

experience and actual exposure, pointing to limited awareness of indoor environmental health risks among residents.

The observed increase in the use of mechanical ventilation and disinfectants among households with chronically ill members indicates adaptive household responses to perceived vulnerability. However, these individual-level practices alone are insufficient to address structurally driven environmental risks, reinforcing the need for upstream interventions targeting housing quality and urban infrastructure.

Overall, the findings highlight the importance of addressing housing conditions as a key social determinant of health and as a dimension of urban inequality. Improving indoor environmental quality in residential settings requires integrated policy approaches that combine housing regulation, preventive maintenance, and public health strategies. Particular attention should be given to vulnerable households who may be disproportionately exposed to substandard environmental conditions.

In addition, strengthening environmental health literacy is essential to bridge the gap between perceived and actual housing conditions. Enhancing public awareness of risks related to dampness, mold, ventilation, and indoor air quality may support more effective prevention and early intervention strategies. This is particularly relevant in urban contexts where environmental risks are often normalized or underrecognized.

Targeted housing and public health policies should therefore prioritize structural improvements, regular maintenance of building infrastructure, and the enforcement of minimum indoor environmental standards. Such measures represent a key opportunity to reduce preventable health risks and to promote more equitable and healthy urban living conditions.

Ethical Approval and Consent to Participate

The study was conducted in accordance with the ethical principles of the Declaration of Helsinki and relevant institutional research standards. Ethical approval was obtained from the competent institutional ethics committee (approval number to be inserted). All participants provided informed consent prior to data collection. Anonymity and confidentiality were ensured by excluding personally identifiable information and storing data in password-protected files accessible only to the research team.

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Availability of Data and Materials

The datasets generated and analyzed during this study are available from the corresponding author upon reasonable request. No supplementary files are publicly

available. All data were obtained through structured questionnaires and direct on-site observations in residential apartments in Durrës.

Authors' Contributions

Anisa Liti: Conceptualization, Methodology, Data Curation, Formal Analysis, Writing – Original Draft; Elida Mataj: Investigation, Validation, Writing – Review & Editing, Supervision

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Declaration on the Use of Artificial Intelligence

The authors declare that artificial intelligence tools were used solely for language editing and grammatical refinement to improve clarity and readability. AI was not involved in data analysis, interpretation, or scientific decision-making. All scientific content, analysis, and conclusions remain the sole responsibility of the authors.

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