

Assessment of Household Mould Growth and Related Health Impacts in Bristol, United Kingdom

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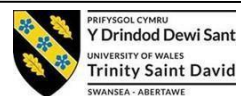


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Abstract

Household mould is a significant public health concern, particularly in urban areas with ageing housing infrastructure and socio-economic inequalities. This research investigates the factors that affect household mould growth and the health effects of mould exposure, with a focus on Bristol, United Kingdom. The data related to household mould and health impacts were collected through a research questionnaire. This survey was done in the city of Bristol, relying on the responses of fifty individual participants. The research questionnaire contained different sections, including personal information, household information, information regarding mould presence, health impacts and mould preventive measures. Data collected through this survey was analysed by IBM SPSS software. Frequency analysis was performed for each selected variable to evaluate the participants' responses to specific questions. Correlation analysis was done to identify the relationships between different factors that contribute to mould growth and their health effects. Three factors significantly affect household mould, as indicated by Pearson Chi-square test P values: presence of moisture sources (0.001), ventilation frequency (0.048), and implementation of preventative measures (0.001). The availability of moisture sources has the strongest correlation with mould growth among the three parameters, as indicated by the comparison of Cramer's V statistics: 0.593, 0.196, and 0.514, respectively. Comparable assessments were conducted to identify the relationships between respiratory symptoms and other relevant factors. Chi-square test P values indicate that the presence of household mould (0.02), mould extent (0.04), and smoking behaviours (0.001) significantly impacts on respiratory problems. Furthermore, smoking habit showed the strongest relationship with respiratory issues from these three variables according to the Cramer's V statistics: 0.395, 0.518 and 0.56 respectively. According to the study findings, it is crucial to aware general public regarding the factors affecting mould formation and its associated health impacts.

Key Words: Household mould, Health effects, Respiratory issues, Mould preventive measures

List of Abbreviations

UK – United Kingdom

BBC – British Broadcasting Corporation

NHS – National Health Service

IBM – International Business Machines

SPSS – Statistical Package for the Social Sciences

ANOVA – Analysis of Variance

1.0.Chapter 1: Introduction

1.1. Household Mould Growth in United Kingdom

People spend a significant amount of time at home all around the world. In the early 2000s, research from Germany, Canada, and the United States found that individuals spend around 65% of their time at home (Brasche and Bischof, 2005; Leech *et al.*, 2002). Since the COVID-19 outbreak in December 2019, instructions to stay at home have likely led to a significant rise in the proportion of persons spending most of their time at home (Mathieu *et al.*, 2020). Despite the removal of mobility restrictions after the pandemic, many people continue to spend a significant amount of time at home. In the United Kingdom, according to statistics from the Office for National Statistics in 2022, 85% of employees working from home desire a 'hybrid' approach to combine home and office work in the future. Fifty of the largest UK companies announced that they intend to return only some employees to the office full-time in the near future. As people spend more time at home than ever before, it is becoming increasingly important that homes be secure and healthy environments.

Housing has a significant influence on both physical well-being and general quality of life, influencing behaviour, relationships, and interactions within communities (Rashidfarokhi and Danivska., 2023). Housing is a crucial aspect of the built environment, offering protection, privacy, security, and comfort in addition to shelter (Patel, 2022). The quality of housing and conditions can have significant impacts on physical and mental health (Rolfe *et al.*, 2020). The emotional, physical, and social aspects of a dwelling can influence a person's well-being. Healthy housing conditions, such as clean air, clean water, and protection from the environmental threats, help to prevent contagious illnesses and respiratory disorders. Conversely, bad housing circumstances can worsen physical health issues (Krieger and Higgins, 2002). Communities are marginalized due to societal inequality and unequal distribution of power and resources face limited or uncertain access to decent housing, leading to poor health outcomes.

Residents may encounter many housing-related issues, including overcrowding, cold temperatures, moisture, mould infestation, loud disturbances from neighbours, poor lighting, and insufficient heating (Pevalin *et al.*, 2008). One of the prevalent challenges faced by homeowners and tenants in the UK is the development of dampness and mould in their properties. The spread of mould in households is a prominent concern in the UK, mostly attributed to the temperate climate, which fosters circumstances favourable for dampness and fungal growth. Mould in residential surroundings is not merely a cosmetic issue, but a significant public health risk that is associated with various health concerns, especially respiratory disorders. Moulds are a varied collection of fungi that flourish in situations characterized by elevated amounts of moisture. They

reproduce through spore production, with these spores being microscopic and capable of being carried through the air, facilitating their widespread dissemination.

Mould species that are commonly found in households in the UK include *Stachybotrys*, *Penicillium*, and *Aspergillus*. Howlett *et al.* (2019) reported that these moulds could develop on a wide range of surfaces, such as walls, ceilings, carpets, and even furniture, in regions with persistent moisture. Various environmental factors, such as the availability of organic material for sustenance, temperature, and humidity, influence the growth and expansion of mould. Mould is typically able to survive in temperatures ranging from 20°C to 30°C and requires a relative humidity of at least 70%. In the UK, these conditions are frequently encountered indoors, particularly in older or poorly insulated dwellings where mould can accumulate on cold surfaces (Howlett *et al.*, 2019).

Dampness is the primary cause of mould growth in UK residences, and it can be triggered by a variety of sources. The development of water droplets is the result of the interaction between warm, moist air and cold surfaces. This frequently happens in rooms that lack adequate ventilation, including bedrooms, kitchens, and restrooms. Moisture from the surroundings is absorbed into the walls of a building, resulting in rising damp. It is more prevalent in older properties that may lack appropriate damp-proof courses. Water enters a building through external walls, roofs, or windows, resulting in penetrating moisture. It may be the consequence of structural deficiencies, including roof leaks or wall cracks. Moisture can be introduced into a residence through water leaks in pipelines, roofs, or gutters, which can foster the growth of mould. Moisture can be trapped indoors due to inadequate ventilation, particularly in areas where water is used frequently, such as bathrooms and kitchens. Moisture is unable to escape due to this lack of air circulation, which results in the growth of mould and condensation (Lopez-Arce *et al.*, 2019).

According to the UK Damp and Mould Statistics 2023, more than half (58%) of privately rented households in England suffer from damp, mould, and/or excessive cold in their houses, totalling around 2.7 million households. The UK Government estimates that between 3% and 4% of social housing households in England have a certain degree of damp and mould. In the year ending March 2021, the UK Housing Ombudsman (an independent agency that settles problems between tenants and social property owners) received 1,993 complaints about damp, mould, and water leaks in social housing. This number has risen to 3,969 complaints from April to December 2022, representing a 99.1% growth. Furthermore, 23% of UK houses had visible mould and 13% had a moldy odor (Menneer *et al.*, 2022).

Since 2022, the media in the United Kingdom has emphasized domestic mould and damp because of the 'cost-of-living' problem. Rising energy prices have driven many households to avoid using heaters to keep their expenses low (Anderson, 2022). Similarly, residents tend to be

less likely to open windows to preserve heat, increasing the danger of mould and moisture accumulating (Sharpe *et al.*, 2015).

In addition to socioeconomic status and behaviours that reduce the consequences of energy issues, poor construction, extreme weather events such as flooding and inadequate home maintenance are all variables that contribute to household damp (Coulburn and Miller, 2022). Climate change has caused concerns about damp and mould dangers since variations in temperature and humidity can create favourable circumstances for mould growth. Climate change mitigation programs focusing on energy efficiency in indoor housing may limit ventilation rates and increase mould development (Vardoulakis *et al.*, 2015).

The prevalence of household mould in the UK is a well-documented issue, particularly in older housing stock. According to the English Housing Survey, approximately 4% of homes in England reported issues with damp, which includes conditions conducive to mould growth. This percentage represents hundreds of thousands of households where residents may be at risk of health problems due to mould exposure. The problem is more pronounced in certain types of housing and among specific socio-economic groups. For example, privately rented homes and older properties are more likely to suffer from damp and mould. Additionally, households with lower incomes are often less able to afford the necessary repairs or improvements to mitigate dampness, such as installing insulation, repairing leaks, or improving ventilation. Geographical factors also play a role in the prevalence of mould. Regions with higher rainfall and humidity, such as the West of England, including cities like Bristol, are more prone to damp and mould problems. In these areas, the combination of older housing stock and climatic conditions creates a higher risk of mould growth.

1.2. Health Impacts of Household Mould

Household mould exposure can have substantial health consequences, especially for susceptible groups. The individuals in this group consist of children, elderly people, individuals with respiratory diseases, individuals with weakened immune systems, and pregnant women. The health consequences of being exposed to mould are mostly linked to breathing in mould spores, which can initiate a variety of symptoms. Mould spores have the potential to develop allergic responses in susceptible individuals, resulting in symptoms such as sneezing, nasal discharge, ocular redness, and cutaneous rash. *Aspergillus* and *Cladosporium* are frequently linked to allergic reactions, according to Moses *et al.* (2019). Breathing in mouldy environments can worsen pre-existing respiratory illnesses, such as asthma, and can cause the emergence of new respiratory problems, such as chronic sinusitis and bronchitis. Research has indicated that children living in households with high levels of moisture and mould are at an increased risk of developing asthma or experiencing a worsening in their asthma symptoms. For instance, in the

UK, a report of the tragic death of two-year-old Awaab Ishak concluded that the child passed away due to a breathing problem caused by exposure to mould in the residence (BBC).

Stachybotrys chartarum along with other comparable moulds have the ability to develop toxic substances called mycotoxins. Mycotoxin exposure has the potential for significant health consequences, such as breathing difficulties, immune system suppression, and in severe instances, brain issues. Nevertheless, the existence of mycotoxins in indoor environments and their effects on health are still areas of active investigation (Nielsen, 2003). Hypersensitivity Pneumonitis is an inflammatory lung illness resulting from an allergic response to inhaled organic dusts, such as mould spores. Occurrence of these is higher in those who experience frequent and prolonged exposure to elevated concentrations of airborne mould spores, particularly those living in houses with severe mould conditions (Barnes *et al.*, 2022). Furthermore, as stated in the UK Damp and Mould Statistics 2023, the National Health Service (NHS) allocates around £1.4 billion annually to address illnesses related to inadequate living conditions, specifically cold and damp residences.

Although the physical health implications of mould in the houses are commonly researched, less is known about its psychological consequences. A considerable number of individuals have documented the psychological distress that these mould concerns can induce; 40% of residents indicated experiencing stress due to damp, mouldy, or excessively chilly conditions in their dwellings. This distress may lead to compromised immune function, hormonal imbalances, cardiovascular impairment as well as increased smoking, and alcohol consumption. Mould in the house can cause feelings of shame and anxiety, especially in areas where people expect to feel safe and secure (Webster, 2015). Housing renovations such as central heating installation, reroofing, replacement windows, thermal insulation, draught proofing, and re-wiring have relatively strong favourable benefits on adult mental health (Liddell and Guiney, 2015).

1.3. Overview of the study

Mould accumulation in the household is one of the most significant problems in UK dwellings. This phenomenon is most frequently observed in low temperatures, especially in the winter season. The objective of this study is to evaluate the occurrence of household mould growth in specific residences located in Bristol, UK. Further, this is aimed to assess the health impacts associated with household mould. The UK climate, characterized by high humidity and frequent rainfall, provides an optimal setting for the proliferation of household mould. Bristol, located in

the South West, experiences relatively high levels of rainfall (more than 800 mm annually) and moderate temperatures, which are conducive to development of household mould.

Bristol, with its rich historical architecture and a variety of housing styles ranging from Victorian terraces to modern apartments, provides an ideal background for studying the issue of household mould. The city's housing stock is diverse, with many types of older properties that may lack modern insulation and ventilation systems, making them more susceptible to damp and mould development. Furthermore, Bristol's socio-economic landscape is varied, with significant disparities in income, housing quality, and access to resources across diverse communities. These factors make Bristol an ideal place for a detailed assessment of household mould growth and its related health implications.

Despite the known risks associated with household mould, there is a considerable lack of comprehensive, localized data on its prevalence in Bristol and its specific impact on residents' health. National surveys and studies have emphasised the widespread nature of mould in UK homes, but there is a requirement for more detailed studies that focus on specific urban areas like Bristol. The city's unique housing characteristics, coupled with its socio-economic diversity, indicate that the problem of household mould may be more prominent in certain areas, potentially leading to significant health impacts among its residents.

The existing literature primarily focuses on the general correlation between indoor dampness, mould, and health outcomes, sometimes neglecting the specific local factors that can affect the intensity and consequences of these problems. In Bristol, the combination of historical housing, climatic conditions, and socio-economic factors may create a unique environment where mould-related health problems are more prevalent or severe. For instance, older buildings that are more susceptible to structural issues, combined with lower-income households that may struggle with maintenance or heating costs, could lead to elevated levels of mould and related health risks. Moreover, there is a need to investigate the awareness and perception of mould-related health risks among Bristol residents. Understanding how residents perceive and respond to mould in their settings, as well as the actions they take (or do not take) to manage it, is important for introducing effective public health interventions. The lack of targeted research on these problems leaves a gap in the understanding of how household mould affects the health of Bristol's population and what are the potential solutions that can be done to address it.

1.3.1. Research Objectives

The primary objective of this dissertation is to comprehensively examine the occurrence of household mould growth in Bristol, UK, and to evaluate its corresponding health impacts on residents. The objective of this study is to conduct a thorough analysis that takes into account the multiple elements that contribute to the growth of mould, and the health consequences for individuals exposed to it. Further, it aimed to identify the socio-economic aspects that may affect both the presence of mould and the severity of its health effects.

1. **To assess the frequency and severity of household mould growth in a representative households in Bristol.** This involves measuring the extent of mould presence in different types of housing, while considering the age, condition, and maintenance of the properties.
2. **To determine the primary environmental and structural factors contributing to household mould growth in Bristol.** This includes investigating the role of housing characteristics, such as insulation, ventilation, and occupancy patterns, in development of circumstances that promote the growth of mould.
3. **To assess the health consequences associated with exposure to household mould among Bristol residents.** The study will focus on recognizing the frequency of respiratory illnesses, allergic reactions, and other health issues that may be linked to mould exposure, with considering on vulnerable populations such as children, the elderly, and individuals with pre-existing health circumstances.
4. **To evaluate the awareness and perceptions of mould-related health risks among Bristol residents and their responses to mould problems in their homes.** This includes understanding the level of knowledge about mould risks, the actions taken by residents to address mould, and any barriers they face in managing mould growth.
5. **To provide recommendations for public health interventions and policy measures aimed at reducing household mould growth and mitigating its health impacts in Bristol.** Based on the findings, this study will suggest strategies for improving housing conditions, raising awareness about mould-related health risks, and supporting vulnerable populations.

1.3.2. Significance of the Study

The present study is significant and holds great value for several reasons. This research contributes to providing specific insights into the situation in Bristol households. Although national studies provide an extensive point of view, localized research can reveal important details related to the specific housing stock, climate, and socio-economic conditions of a particular area. The significance of this study extends to focus on broader issues of housing inequality in Bristol. Poor insulation, inadequate heating, and delayed maintenance are the primary factors contributing to the increased prevalence of mould growth in lower-income households. Research in this area can be used to inform policymakers aimed at reducing housing disparities and ensuring that all residents have access to safe and healthy living conditions.

The city of Bristol is particularly susceptible to mould growth due to its distinctive climate, which is characterized by frequent rainfall and high humidity. In this context, the examination of household mould is crucial for comprehending the extent to which climate factors influence the quality of indoor air. This research is crucial for the development of climate adaptation strategies that correspond to the unique environmental challenges that the city experiences. Sustainability initiatives are also interconnected with research on household mould growth. The city's broader sustainability objectives can be achieved by enhancing the insulation, ventilation, and energy efficiency of residences, which can also mitigate the conditions that contribute to the growth of mould. This investigation has the potential to inform the formulation of policies that prioritize sustainable housing practices, which would be advantageous to both public health and the environment.

This study aims to identify the specific patterns of mould and health impacts giving insights in how best public health interventions can be targeted by concentrating on a single city, its housing stock, demographic groups and geographical locations. The work will address a major public health challenge with immediate and far-ranging consequences for the well-being of people in Bristol. Health problems associated with mould range from minor symptoms such as itchy eyes, runny nose and sore throat to serious respiratory conditions and even contribute to on-going chronic disease or worsening health in the case of pre-existing medical concerns. This is important for public health strategies and clinical practices interested in both preventing, identifying and treating them. Health problems caused by mould add to overall healthcare costs through an increase in the number of hospital admissions especially those related to respiratory issues. Having insights into how mould is prevalent in Bristol and its effects will allow public health officials to come up with ways that prevent diseases due to mould infestations that overtime can lower costs of healthcare as well improve the quality of life for the entire population.

The study focus on socio-economic factors provides valuable insights into the ways in which income, education, and access to resources influence both the risk of mould exposure and the ability to respond to it. This aspect of the research is particularly important for addressing health inequalities, as lower-income households may be disproportionately affected by mould-related problems. The significance of this research also lies in its potential to raise awareness among the public about the risks associated with household mould. Educating residents about the causes and prevention of mould growth can empower them to take proactive measures to protect their health. This is particularly important in Bristol, where community-driven initiatives can play a vital role in addressing local health challenges.

Finally, the study has practical implications for housing policy and public health strategies in Bristol and potentially other urban areas with similar characteristics. The recommendations derived from the research can inform efforts to improve housing conditions, enhance public awareness of mould risks, and support vulnerable populations in managing mould-related health risks. In doing so, the study aims to contribute to the broader goal of improving indoor environmental quality and reducing health disparities in urban settings.

Due to its extensive implications for public health, housing policy, economic equity, and environmental sustainability, the investigation of household mould growth and its health effects in Bristol, UK, is of considerable significance. This research not only aids in the identification of the underlying causes of health issues related to mould, but it also establishes a foundation for the development of effective interventions and policies that can enhance the quality of life for all residents, particularly those who are most vulnerable. Accordingly, it is an essential field of research to guarantee a more equitable and healthier Bristol.

2.0. Chapter 2: Literature Review

In order to contextualize the research, it is crucial to examine the existing literature on residential mould growth, its health consequences, and the factors that contribute to its prevalence. Numerous studies have emphasized the health issues that come from exposure to mould spores. Research has consistently demonstrated that exposure to indoor mould can result in a variety of health issues, particularly respiratory problems such as asthma, allergic rhinitis, and chronic sinusitis. For example, according to a study conducted by Fisk *et al* in 2007, there is a substantial correlation between the prevalence of respiratory symptoms and asthma in occupants and the indoor moisture and mould. In addition, Jaakkola *et al* in 2005 reported that the risk of asthma and other respiratory conditions was elevated in individuals who were exposed to mould aromas.

The literature also indicates that socio-economic factors play a crucial role in the prevalence of mould and its health effects. Older, improperly maintained dwellings that are susceptible to dampness and mould are more prevalent among low-income households. Additionally, these households may have limited access to resources for managing moulds issues, including professional cleaning services, dehumidifiers, or adequate heating. Research has demonstrated that socio-economic status is a substantial predictor of domestic environmental quality, with lower-income households being at a higher risk of exposure to environmental hazards such as mould (Evans and Kantrowitz, 2002). The literature reveals that there is a gap between the actions taken to mitigate the health risks associated with mold and the level of awareness of these risks in the context of public health. In 2011, Mennell *et al* conducted a study that emphasized the necessity of increased public awareness and education regarding the health concerns associated with indoor mould. The research indicated that although many individuals are knowledgeable of the potential hazards of mould, they may not possess an accurate understanding of the extent of the hazards or the most effective methods for managing mould in their residences.

The age and design of UK housing stock play a critical role in mould growth. Ormandy and Ezratty (2012) highlight that older homes, especially those built before the 1970s, are more likely to have poor insulation, single-glazed windows, and inadequate ventilation systems, all of which contribute to condensation and dampness. Research by Garrett *et al* in 2012 emphasizes the importance of regular maintenance and proper ventilation in preventing mould growth, especially in homes with high humidity levels. In 2007, Fisk *et al* conducted a meta-analysis that found a consistent association between indoor dampness and mould with an increased risk of asthma and other respiratory conditions. Research by Liddell and Morris (2010) suggests that the stress associated with living in damp and mouldy conditions can lead to mental health issues such as anxiety and depression.

In terms of public health, the literature suggests that there is often a gap between awareness of mould-related health risks and the actions taken to mitigate these risks. A study by Mendell *et al* (2011) highlighted the need for increased public awareness and education about the health risks associated with indoor mould. The study suggested that while many people are aware that mould can be harmful, they may not fully understand the severity of the risks or how to effectively manage mould in their homes.

Research on the prevalence of household mould in Bristol indicates that it is a widespread issue, particularly in certain types of housing and neighbourhoods. A report by the Bristol City Council (2019) noted that privately rented homes are more likely to experience mould problems compared to owner-occupied homes. This sector includes a high proportion of older, poorly maintained properties, which are more susceptible to damp and mould. There is significant geographical variation in the prevalence of mould within Bristol. Areas with a high concentration of older housing, such as Easton, St. Paul's, and Lawrence Hill, report higher instances of damp and mould (Bristol City Council, 2019). These areas also tend to have higher levels of socio-economic deprivation, which correlates with increased mould-related issues. The Cabot Institute for the Environment at the University of Bristol has published reports on climate change's impact on health, including the exacerbation of housing-related health issues like mould. These reports underscore the importance of addressing both the physical aspects of housing and the broader climatic conditions that contribute to mould growth (Cook and Stephan, 2015).

A study conducted by the Bristol City Council in collaboration with local universities found that many homes in Bristol, particularly those in lower-income areas, are inadequately equipped to deal with the city's damp climate. This study emphasizes the need for improved building maintenance and modernization to prevent mould growth in these older structures (Bristol City Council, 2017). The Bristol Health Partners report (2018) noted a correlation between the presence of mould and increased hospital admissions for respiratory issues, particularly during the winter months when homes are less ventilated. A study by Liddell and Guiney (2015) examined the link between poverty and exposure to poor housing conditions, including mould. The research found that low-income households in Bristol are disproportionately affected by mould, as they often reside in poorly maintained homes with inadequate heating and insulation. This socioeconomic disparity contributes to health inequalities across the city. Research conducted by the Bristol Fairness Commission highlighted that social housing tenants are more likely to experience issues with mould, partly due to a lack of resources for timely repairs and maintenance. The commission's report called for more robust housing policies to protect vulnerable populations from the health risks associated with mould exposure (Donovan Wilson, 2023).

Cultural and ethnic minority groups in Bristol may face additional barriers in addressing mould issues, including language barriers, lack of awareness about tenant rights, and fear of eviction (Race Equality Foundation, 2015). These factors contribute to the persistence of mould problems in certain communities. Strengthening regulations around rental housing standards can help reduce the prevalence of mould. The Homes (Fitness for Human Habitation) Act 2018 requires landlords to ensure that their properties are free from hazards, including damp and mould, which provides a legal framework for addressing these issues in rental properties (Ministry of Housing, Communities & Local Government, 2018). The need for stronger regulatory frameworks was emphasized in a study by Howden-Chapman *et al* (2007), which discussed the effectiveness of housing regulations in mitigating mould growth. The study called for better enforcement of existing regulations and the introduction of new standards to ensure that all homes in Bristol are adequately insulated and ventilated.

Bristol City Council has implemented specific measures to address mould in housing, including providing guidance to landlords and tenants on preventing and dealing with mould. The council also offers financial assistance for necessary repairs in qualifying homes. Initiatives such as the Bristol Home Energy Upgrade program aim to improve energy efficiency in homes, thereby reducing the conditions that lead to mould growth. This program includes insulation grants and advice on effective heating strategies. Public health researchers have advocated for the integration of mould prevention into broader public health strategies. The Bristol Health Partners (2018) report recommended that housing interventions be considered a critical component of public health policy, particularly in addressing respiratory diseases and health inequalities.

Despite the known risks associated with household mould, there is a lack of comprehensive data on the extent of mould growth in Bristol homes and its direct impact on the health of residents. While previous studies have explored the presence of damp and mould in UK housing, specific data on Bristol is limited, leaving a gap in understanding the local dynamics of this issue. Additionally, the relationship between socio-economic factors, housing conditions, and mould-related health impacts in Bristol has not been fully explored. This study aims to address these gaps by providing a detailed assessment of household mould growth and related health outcomes in the city.

3.0. Chapter 3: Research Methodology

This chapter outlines the research structure, methodology, and procedures that were implemented in the qualitative evaluation of the health consequences of household mould in Bristol, UK. In order to capture the experiences of affected households, a qualitative approach was selected due to the complex nature of mould exposure and its potential health effects. This methodology allows an in-depth analysis of the social context, personal accounts, and opinions associated with mould exposure, thereby providing a comprehensive understanding of the issue.

The chapter's primary topics are the research design and the discussion of the importance of selecting a qualitative framework. In addition, the data collection methods, methods used to data analysis, and participant selection criteria are described in this section. In order to ensure the accuracy and dependability of this research process, ethical considerations, such as confidentiality and informed consent, are further addressed. This chapter ensures that the results of the study are both credible and based on strong qualitative analysis since it was systematically establishing the methodological steps from research design to interpretation of data.

The research design is an important part of any study as it determines the overall approach and strategy for investigating the research problem. This study follows a qualitative research design, which is particularly appropriate to identify complex and context-dependent issues such as health problems associated with household mould. Qualitative research is a valuable and optimal choice for understanding the meanings and interpretations individuals ascribe to their experiences. A phenomenological approach was used to guide the research and collect data. This is concerned with investigating and describing the daily life experiences of individuals, with the objective of finding the essence of those experiences. This approach consists of the study's objective of understanding how residents in Bristol are susceptible and aware of household mould, providing deep understanding and detailed insights into their health impacts.

This particular research was designed with the data collection through a research questionnaire. The success and efficiency of any qualitative assessment are significantly influenced by the design of the research questionnaire. Hence, this research study also required well-designed survey responses to identify the health impacts of domestic mould. The design of the questionnaire is not only a procedural step in the context of this study but also a foundational element that determines the quality, depth, and significance of the data collected. The research's capacity to accurately represent the varied experiences, opinions, and health outcomes of individuals affected by household mould is ensured by the accurately designed research questionnaire. The questionnaire must be carefully created to investigate the broad elements associated with the issues. The questionnaire is a tool that is used to facilitate the interview process, ensuring that every relevant topics are addressed while also allowing participants to share their unique experiences.

The most important aspect of a perfectly designed research questionnaire is that it has the ability to correspond with the specific research objectives of the study. In order to achieve the objectives, determining the nature and severity of mould development in Bristol households, identifying the health consequences, and examining the social and environmental aspects are critical components of the current study. Therefore, the research questions were designed with directly associated with these aspects. The current questionnaire is composed of six sections to facilitate the collection of data with greater precision, as outlined below: (Appendix 01).

- Section 1: Personal Information
- Section 2: Household Information
- Section 3: Mould Presence and Extent
- Section 4: Health Symptoms
- Section 5: Preventive Measures and Remediation
- Section 6: Additional Comments

It is essential to collect personal information in a research questionnaire. The study's findings are pertinent, accurate, and actionable because personal information provides the context necessary to comprehend the broader implications of the data collected. One of the primary objectives of collecting personal information in this research questionnaire is to interpret the health impacts reported by participants. The severity and nature of health outcomes can be substantially impacted by a variety of personal and environmental factors. In this questionnaire age, gender, ethnic group, occupation and educational level are considered as major responses. Household information such as housing tenure, number of people living in the house, and type of dwelling provides insight into the living conditions that may contribute to mould growth and exposure. Additionally, the questionnaire addresses the ventilation type of the house, moisture sources of the house, maintenance, and household habits.

In the present survey, questions about mould presence and extent are crucial. Consequently, the presence of mould, the primary locations of mould in houses, the extent of mould growth, and the experiences observed in mouldy areas are all taken into account. Health information is another essential section for identifying vulnerable populations who may be disproportionately affected by household mould. Gathering the health information enables the study to highlight which groups are most at risk and to recommend targeted interventions that address their specific needs. The section five provides information regarding any preventive measures and remediation that has been taken to control household mould. Further, a question is designed to identify the challenges to manage and control household mould.

Including an additional comments section in a household mould-related research survey is important for several reasons. The survey questions may not directly inquire about the experiences or observations of respondents. Therefore, in this section, they are able to share their understandings, which may reveal new aspects of mould exposure or related issues. The knowledge that they have the opportunity to provide any supplementary information may motivate a greater number of individuals to participate in the survey, particularly those with complex or unique experiences.

This research questionnaire incorporates both open-ended and closed-ended questions. In order to effectively collect a high volume of data from the respondents, closed-ended questions provide quantifiable data that are straightforward and can be easily analysed. These questions help to gather specific information, and these data are crucial for identifying patterns and trends in mould-related problems. Similarly, respondents have the opportunity to express their opinions, experiences, and suggestions in their own words through open-ended questions. These data are important in understanding the fundamental causes of mould issues, the impact on health and property, and any unique challenges experienced by the people who participated. These two strategies not only enhance the validity and reliability of the research but also increase the possibility of identifying effective answers to problems associated with household mould.

Another important concern of questionnaire design is to make sure that questions are clear and easily understood by the selected participants. In qualitative research which aims to gather rich, accurate, and detailed information, any uncertainty in the responses can be resulted in to confusion, misinterpretation, and unreliable data. The preparation of questions should be carefully considered to avoid technical terms, misleading questions, or complex language that interferes with participants' ability to respond accurately. As an example, the term 'respiratory issues' was replaced with 'breathing issues' in order to make it more easily understandable for people in general.

The procedure of selecting respondents for the research questionnaire requires careful consideration in order to make sure that the study is equitable, relevant, and able to successfully accomplish its research objectives. It is important to participate in several localities within Bristol, including both urban and suburban regions in order to ensure wide sample diversity. A random sampling method was used to select participants randomly from the target population by ensuring every individual has an equal chance of being included. This approach helps in achieving a representative sample of Bristol's population. For more comprehensive study purposive sampling was used to select participants who have specific experiences with mould such as individuals who have had health issues related to mould or those who live in particularly damp areas of Bristol.

A pilot test of the questionnaire was carried out with a limited number of participants (10 participants) before conducting the full questionnaire. This helps refine the questionnaire ensuring that questions are clear and the sample selection method is effective. Thereafter, 50 individuals were considered for the final survey in the area of Bristol. Participants were fully informed about the primary objectives of the survey, its questions, how the data will be used, as well as the potential advantages and disadvantages associated with their participation. Accurate information about the survey's objectives, methodology, data analysis, and outcomes was provided when requested. Personal identifiers such as names and addresses were not used to protect participants' identities. In addition, only those who voluntarily agreed to participate were chosen, and respondents were given the freedom to withdraw from the questionnaire at any time without facing any adverse consequences.

In areas known for mould problems, door-to-door surveys are more effective. This method allows to directly reach people who may not be active online or who are less likely to respond to digital surveys. Consequently, a paper-based survey was conducted to reach specifically target people that may be missed in online research, including elderly individuals, low-income households, and those residing in places with limited internet availability. Unlike online surveys, which are subject to interruptions from notifications, advertisements, or other digital distractions, paper surveys provide a concentrated setting that may result in more accurate and thoughtful responses. In addition to the questionnaire, observational data were collected during home visits to the few participants' residences. These observations provided relevant information on the physical environment such as the extent and location of mould growth. These findings were documented through field notes and photographs with the participants' permission. These observations helped to prove the participants' responses and added depth to the analysis.

A systematic approach was used to perform data analysis on a research questionnaire. Data were analysed using IBM SPSS (Statistical Package for the Social Sciences) software. Demographic data were considered including age, gender, income level, and other relevant factors, in order to get information about the distribution of respondents. The percentage of respondents who report mould issues was calculated and analysed the frequency and severity of occurrences. The study examined the correlations between several variables, such as the correlation between the characteristics of buildings and the presence of mould. Charts and graphs were created as an efficient way of conveying research results. Based on the analysis, actionable recommendations will be provided at the end of this dissertation to address the mould issues.

4.0. Chapter 4: Results and Discussion

4.1. Results and Data Analysis

This chapter focuses on analysis and discussion of the results obtained from questionnaire conducted in the city of Bristol. The data on mould was analysed using the IBM SPSS (Statistical Package for the Social Sciences) software. This software is widely used for statistical analysis, which allows for the processing and interpretation of research data. The interface of the software is designed to be straightforward for users to explore, and it offers a variety of statistical functions that are capable of performing a wide range of studies. These analyses can range from simple descriptive statistics to more complex inferential techniques. Visualizing data is essential for understanding and interpreting survey findings. SPSS offers a comprehensive set of tools for generating a diverse range of charts and graphs, including bar charts, pie charts, histograms, scatterplots, and boxplots. The graphical representations facilitate the identification of patterns, trends, and outliers in the data, hence improving the presentation of results (Pallant, 2013).

Before conducting the analysis, it is essential to systematically input and organize the data obtained from questionnaires into the SPSS interface. The questions in the survey should be associated with the variables in SPSS, and the answers provided should be assigned number codes, such as 1 for 'Yes' 2 for 'No' etc. Each variable was allocated descriptive labels and value labels to improve the interpretability of the data. Firstly, the reliability test was done to check the reliability of the questionnaire. Reliability Statistics and ANOVA table were used for the analysis. According to the SPSS Survival Manual (Pallant, 2013), for the reliability and validity of research tool and for a better internal consistency Cronbach's Alpha should be equal or greater than 0.7 with a significant value of $P \leq 0.005$. For this questionnaire, Cronbach's Alpha value was 0.712 with a significant value 0.001. Therefore, the internal consistency was good and the analysis will give credible results.

Frequency analysis in SPSS is a common method used to analyse survey data, particularly for categorical variables such as demographic information, responses to the scale questions, and other discrete data points. Frequency tables were produced for each selected variables and these tables show the frequency and percentage of each category within the variable. Further, pie charts were created to visually represent the data.

The frequency analysis of age indicates that 36% of respondents were in 45-60 age group, 30% of them were in 30-45 age group, 28% of respondents were in 60-75 age group and only 6% were in 18-30 age group as shown in following Figure 4.1. This analysis indicates that the majority of respondents were middle-aged and elderly, with only 6% of participants being under the age of 30.

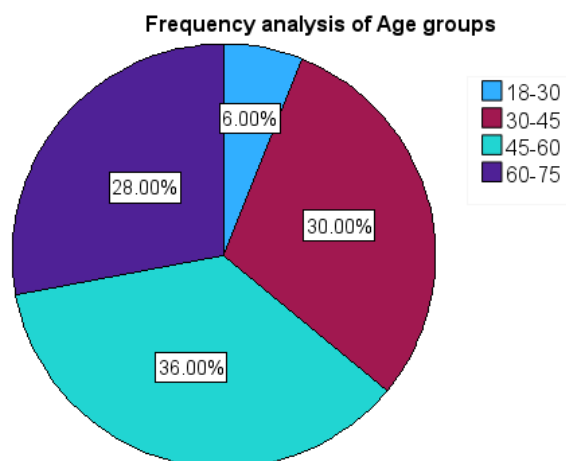


Figure 4.1: Percentages of participants in each Age group

The gender frequency analysis reveals that 56% of participants were female, 40% were male, and 4% belonged to other gender categories (Figure 4.2). This means the majority of participants were female.

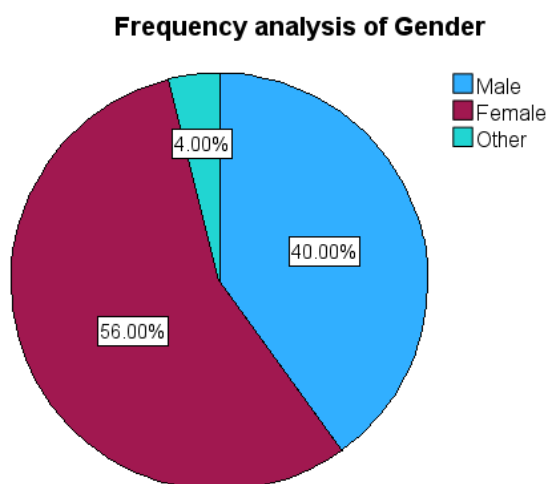


Figure 4.2: Percentages of participants in each Gender type

According to the frequency analysis of ethnic group, 44% were Asian or Asian British, 28% were White, 14% were black or African and 14% were others represented as Figure 4.3.

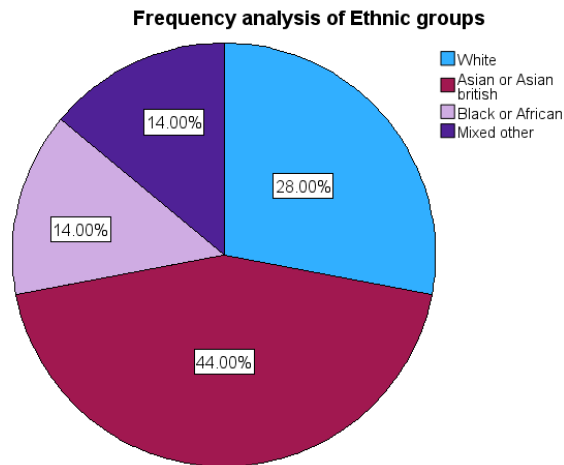


Figure 4.3: Percentages of participants in each Ethnic group

When analysing the educational level of the respondents, 40% hold a bachelor's degree, 28% reported having a postgraduate degree, 28% had completed their A-levels, and 2% had just completed secondary education. These percentages are represented in the following pie chart, labelled as Figure 4.4.

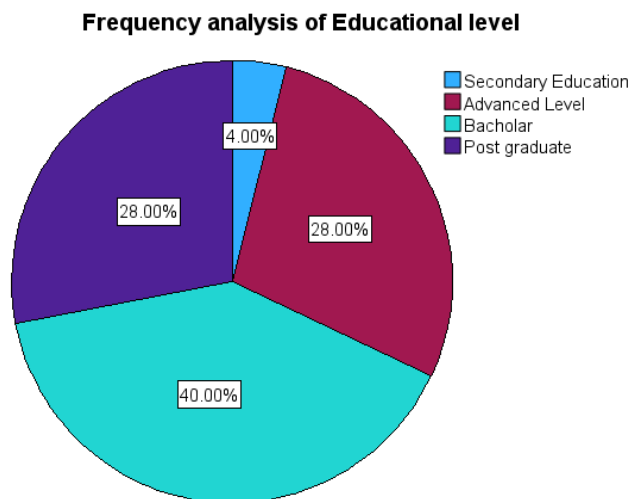


Figure 4.4: Percentages of participants in Educational level

Household information were included in the second section of the questionnaire. According to the results of the survey, 40% were lived in flats, 32% in semi-detached houses, 16% apartments and only 12% in detached houses (Figure 4.5).

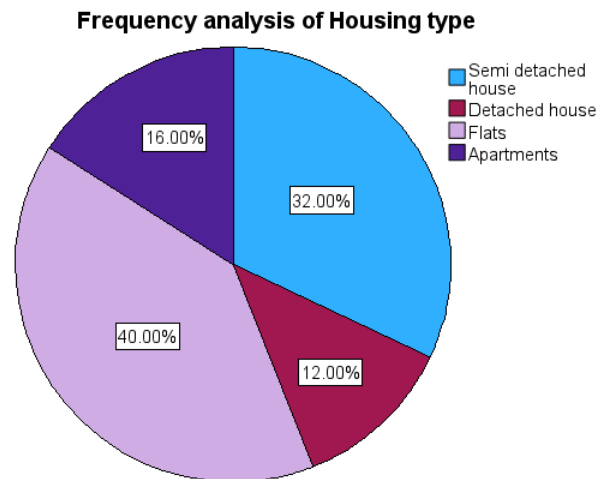


Figure 4.5: Percentages of participants living in each housing type

Based on the survey results, 56% of respondents lived in rented houses, 30% lived in houses they owned, and 14% lived in social housing, as illustrated in Figure 4.6. This indicates that a large number of the participants lived in rented houses.

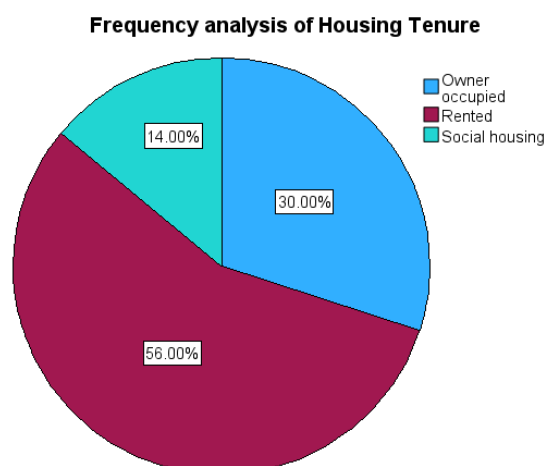


Figure 4.6: Percentages of participants in each housing tenure

According to the results of questionnaire analysis, 84% of respondents answered that they do not have any pets and only 16% of participants have pets in their household as shown in following Figure 4.7.

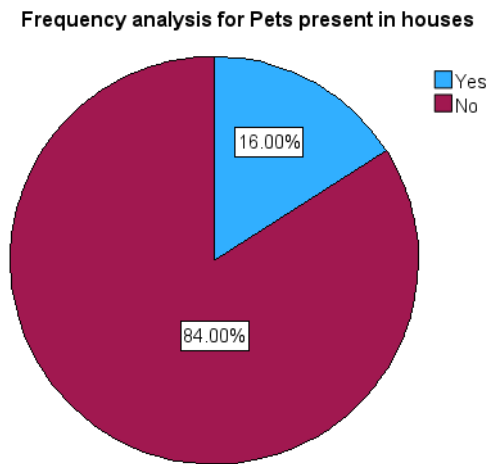


Figure 4.7: Percentages of participants having pets in their houses type

The questionnaire included a question about household ventilation, specifically asking participants about the frequency with which they ventilate their homes. The findings indicated that 4% of respondents ventilate frequently during the day, 40% ventilate once per day, 44% ventilate on a weekly basis, and the other 12% ventilate rarely. This is illustrated in the following Figure 4.8.

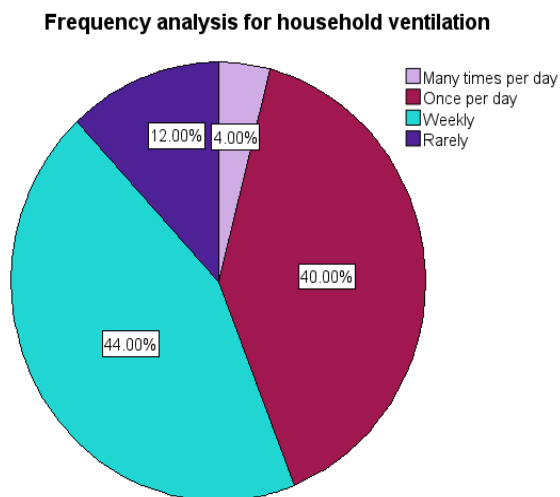


Figure 4.8: Percentages of participants' household ventilation frequency

When reviewing the sources of moisture in households, 82% of respondents reported having some form of moisture source in their homes. 10% responded that they have no experience, while 8% were uncertain (Figure 4.9). These moisture sources include leaking pipes, roof leaks, poorly sealed doors/window, and window condensation.

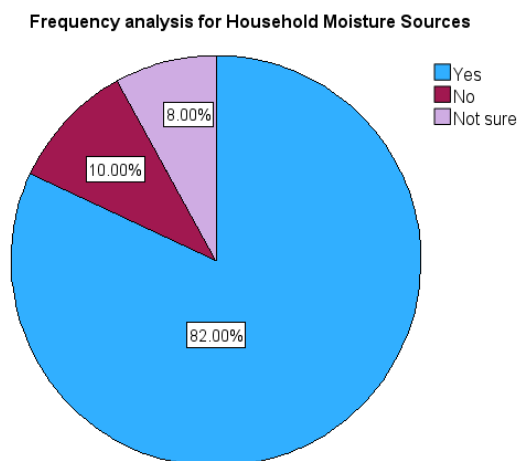


Figure 4.9: Percentages of participants having household moisture sources

Moreover, the study included a question regarding the practice of smoking indoors. Out of the respondents, 40% confirmed that taking part in this behaviour, while the remaining 60% stated that they did not smoke which is illustrated in the following Figure 4.10.

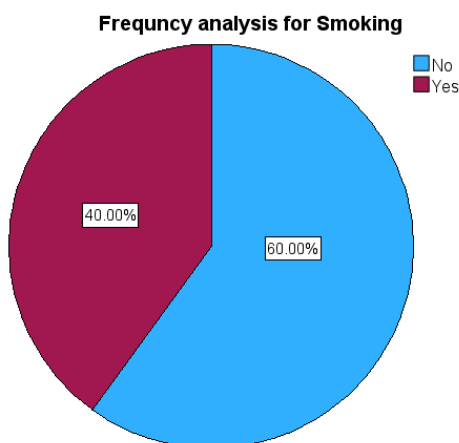


Figure 4.10: Percentages of participants smoking inside the houses

When considering the regular maintenance of the houses only 6% were answered they are doing while the remaining 94% answered that they have not done regular maintenance as shown in the following Figure 4.11. This indicates that the majority of respondents were not doing regular maintenance, while just a minority engaged in such practices.

Frequency analysis for regular maintenance of house

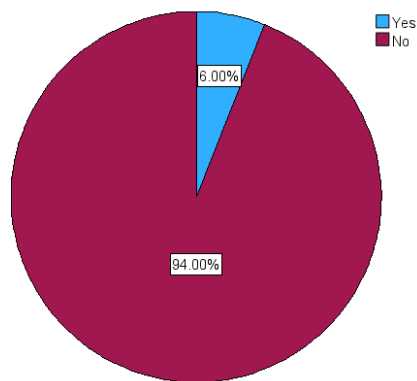


Figure 4.11: Percentages of participants doing regular maintenance in their houses

Mould presence and extent was determined in the third section of the questionnaire. Out of the respondents, 78% reported noticing visible mould in their homes, 6% said they did not, and 16% were unsure which is illustrated in Figure 4.12 pie chart. Majority of participants have mentioned that they observed mould only in bathrooms and kitchens while others observed in bed rooms as well.

Frequency Analysis for Mould present in household

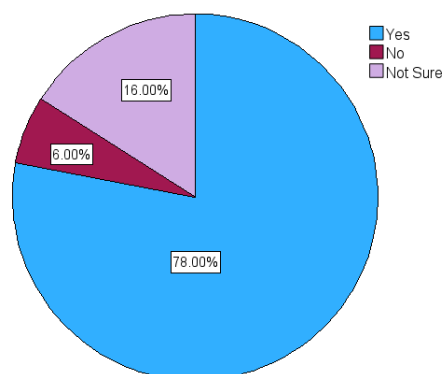


Figure 4.12: Percentages of participants having mould in their houses

When considering the extensive of mould growth 38% mentioned moderate mould growth, 26% were observed extensive mould growth, 14% were experienced only small patches while other 22% were not answered the question (Figure 4.13).

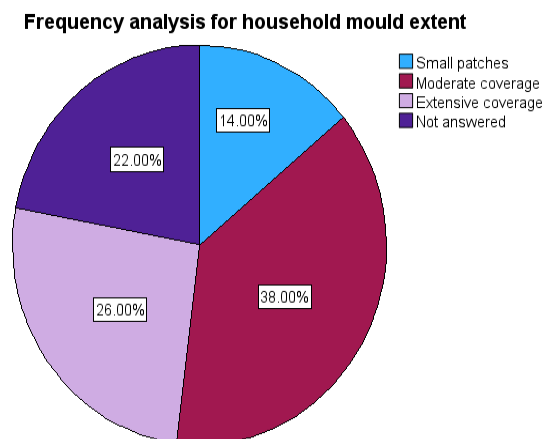


Figure 4.13: Percentages of participants household mould extent

Health symptoms associated with household mould were considered in section 04. 68% of the participants said that at least one household member experiences respiratory problems, while 32% reported no such issues (Figure 4.14). Other than respiratory issues, many other symptoms were considered such as eye irritation, skin rashes or irritation, headaches or migraines, nausea or vomiting, and neurological symptoms.

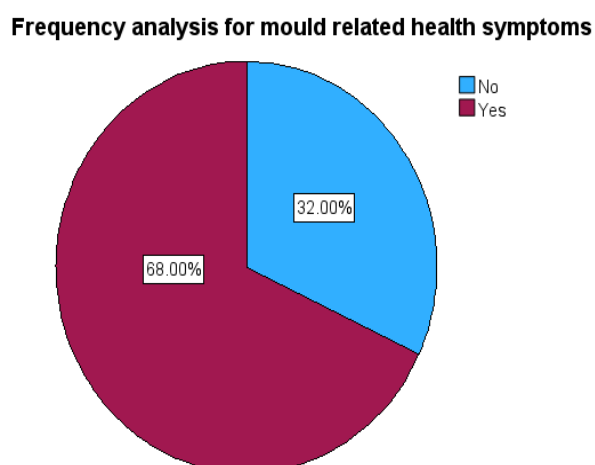


Figure 4.14: Percentages of participants mould related health symptoms

Section 5 evaluates preventive measures and remediation for mould control. According to the survey results, 74% participants have reported that they have taken any preventive measures to control mould and 26% were not (Figure 4.15).

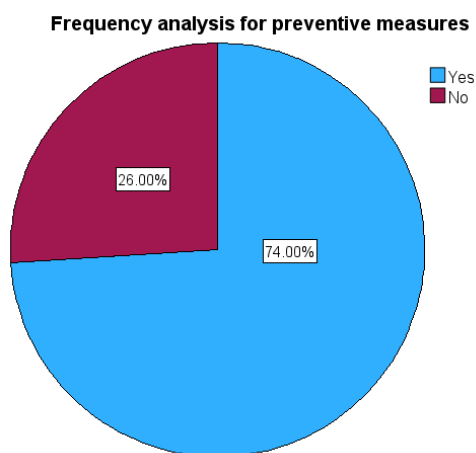


Figure 4.15: Percentages of participants who have done preventive measures to control household mould

Further, effectiveness of those preventive measures were checked. The results indicate that 14% of the participants found the intervention to be highly effective, 22% found it to be moderately effective, 26% found it to be slightly effective, 12% found it to be ineffective, and the remaining 26% did not provide a response (Figure 4.16).

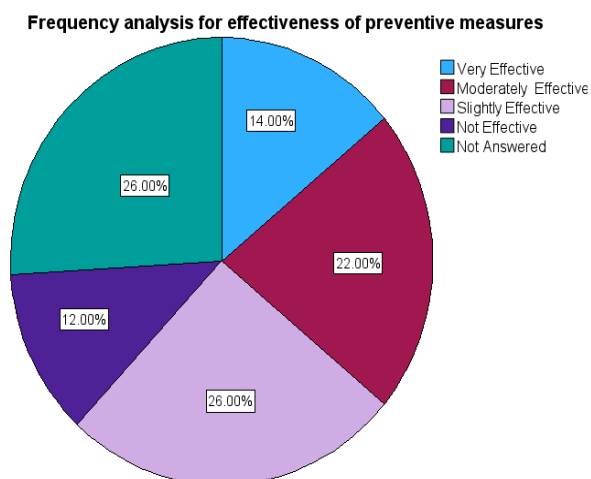


Figure 4.16: Percentages of participants based on the answers for effectiveness of mould preventive measures

In order to gain a more comprehensive understanding of the dynamics of household mould in diverse factors and determine the relationships between different variables, a correlation analysis was conducted using SPSS. Understanding the relationships between different factors, mould growth, and health impacts is essential for formulating effective prevention and remediation strategies. By analysing the correlation between variables, the patterns, and potential causes can be identified that influence the growth of mould and its impacts on human health. This questionnaire contains several nominal variables such as the existence of mould, smoking, ventilation, related health symptoms, preventive measures, and maintenance. Hence, in order to determine the relationships, non-parametric correlation analysis was conducted for each variable.

The Crosstabulation was done following the Pearson Chi-square tests and Cramer's V to evaluate the relationships between different parameters and variables. The Chi-Square Tests table in SPSS provides the results of the chi-square test for two different variables. This table includes the Chi-square statistic, the degree of freedom, and the p-value. The p-value below 0.05 indicates there is a statistically significant correlation (at the 5% level) between the two variables in the test, whereas a p-value above 0.05 suggests there is no statistically significant relationship. (Almquist *et al.*, 2020).

Cramer's value is used to measure the strength of correlation between two types of variables when a Chi-square test reveals a statistically significant relationship. The range of this value is from 0 to 1, where 0 represents no correlation and 1 indicates perfect relationship. According to the SPSS Survival Manual (Pallant, 2013), the correlation strength is described as follows: 0 to 0.1 indicates a weak relationship, 0.1 to 0.3 indicates a moderate relationship, 0.3 to 0.5 indicates a strong relationship, and values above 0.5 indicate a very strong relationship.

One important objective of this research questionnaire is to determine different factors that influence the growth of household mould. Therefore, the initial step involved conducting a Chi-square test to examine the associations between those characteristics and the presence of mould. The test results conducted to assess the relationships between several variables and the presence of mould are summarized in the following table 4.1. P value and Cramer's V for each factor with the present of mould were included to the table in order to interpret results meaningfully.

Table 4.1: Summary table for the results of Crosstabulation followed by Pearson Chi-square test and Cramer's V; Each variable with Presence of mould

Variables	P Value	Cramer's V
Housing type and the Presence of mould	0.197	0.034
Housing tenure and the Presence of mould	0.399	0.201
Pets and the Presence of mould	0.121	0.368
Moisture sources and the Presence of mould	0.001	0.593
Ventilation and the Presence of mould	0.048	0.196
Maintenance and the Presence of mould	0.965	0.012
Preventive measure and the Presence of mould	0.001	0.514

Firstly, the correlation between housing type and the presence of mould was tested. The results indicate that the p-value is 0.197, which exceeds the limit of significance of 0.05. Therefore, this suggests that there is no statistically significant correlation between the type of housing and the presence of mould. A similar study was done by Moon and Yoon in 2010 reported that statistically significant difference was not found among the types of dwellings and household mould growth.

When examining the association between housing tenure and the presence of mould, the p-value is 0.399, which is greater than the significance level of 0.05. This indicates that there is no statistically significant relationship between the type of residence tenure and the occurrence of mould. Similarly, some studies, such as Howden *et al.*, 2005, have reported there is no significant association between these two variables. In contrast, Coulburn and Miller (2022) reported that rental residences are more susceptible to the proliferation of mould compared to owner-occupied houses. The p-value of the Chi-square test for the presence of pets in homes and mould growth is 0.121. Given that the p-value is greater than 0.05, indicates that there is no statistically significant correlation between the presence of pets in households and the growth of mould.

The p-value for the relationship between the presence of household moisture sources and mould occurrence is 0.001. Since the value is below 0.05, this indicates a statistically significant relationship between these two variables. In addition, when considering Cramer's V, the reported value is 0.593. This suggests a highly significant statistical correlation between the presence of moisture sources and the occurrence of mould. This suggests that the presence of moisture sources is an important factor that contributes to the growth of mould in households.

In addition, many research studies have confirmed and reported this correlation (Howden *et al.*, 2005, Coulburn and Miller, 2022). Hence, when addressing mould-related issues, it is especially important to take into account the sources of moisture within the household. Moreover, the questionnaire took into account the frequency of ventilation. The results indicate that the p-value for the test between ventilation frequency and the presence of mould is 0.048. Since the value is below the threshold of 0.05, it may be concluded that there is a statistically significant correlation between ventilation frequency and the occurrence of mould. Furthermore, based on the calculation of Cramer's V, the resulting value of 0.196 indicates a moderate correlation between these two variables. Based on the findings, it can be concluded that regular ventilation reduces the occurrence of mould growth, while infrequent ventilation leads to higher levels of mould growth. Several research studies have also reported similar conclusions on domestic ventilation and mould growth (Menneer *et al.*, 2022; Moon and Yoon, 2010).

When considering regular maintenance and the growth of mould, the p-value obtained from the test is 0.965. The value exceeds the threshold of 0.05, indicating that there is no statistically significant association between the two variables. The cross-tabulation results indicate a correlation coefficient of 0.001 between performing preventive measures and the existence of mould. Since the value is less than 0.05, it can be concluded that the correlation between preventive measures and the presence of mould is statistically significant. When analysing the Cramer's V statistic, the obtained value of 0.514 indicates a significant and strong correlation between the above two parameters. This implies that if individuals are implementing appropriate preventive measures for mould control, minimal or no mould development could be expected. Many research studies, including Eeckhout *et al.*, 2013, Moon and Yoon, 2010, and Howden *et al.*, 2005, have confirmed this statement.

According to the above interpretation, the variables that have a statistically significant influence on the growth of household mould are the presence of moisture sources, the frequency of ventilation, and conducting preventive measures. When analysing and comparing Cramer's V statistic, it is evident that the existence of moisture sources has the strongest association for mould growth among these three components. Performing preventive measures comes second in regards to correlation, while ventilation frequency could be considered as a third factor.

Evaluating the health issues, particularly respiratory problems, associated with the presence of mould is another crucial objective of the study. Therefore, the same crosstabulation technique was applied to determine the correlations between respiratory symptoms and other relevant factors. The test results, which aimed to evaluate the correlations between different variables and the presence of respiratory symptoms, are presented in the following table 4.2. The table includes the P value and Cramer's V for each element that is associated with respiratory issues, in order to facilitate an accurate analysis of the data.

Table 4.2: Summary table for the results of Crosstabulation followed by Pearson Chi-square test and Cramer's V; Each variable with Respiratory problems.

Variables	P Value	Cramer's V
Gender and Respiratory problems	0.629	0.136
Ethnic group and Respiratory problems	0.144	0.329
Educational level and Respiratory problems	0.286	0.275
Presence of Household mould and Respiratory problems	0.020	0.395
Mould extent and Respiratory problems	0.040	0.518
Participant's Smoking habit and Respiratory problems	0.001	0.560

When conducting a cross tabulation study on the relationship between participants' gender and the presence of respiratory difficulties, the obtained p-value was 0.629. Consequently, it can be determined that there is no significant statistical association between gender and respiratory issues. A similar analysis was performed to assess the correlation between the ethnic group and the presence of respiratory problems. The results presented here suggest that the p-value is 0.144, indicating an absence of statistical correlation between the two variables. Another parallel analysis was carried out to evaluate the relationship between the level of education and the occurrence of breathing-related problems. The findings reported in this test indicated that the p-value is 0.286, which suggests there is no evidence of statistical association between the two factors.

Furthermore, the study examined the correlation between the presence of household mould and health concerns, in addition to personal data. According to the data presented in Table 4.2, the p-value for this test is 0.02. The value is less than 0.05, indicating that the association between the two factors is statistically significant. Considering Cramer's V, it reported as 0.395 that means the correlation between mould and respiratory problems is strong. Additionally, an analysis was conducted to examine the correlation between the extent of mould and respiratory issues.

The presented data indicate a p-value of 0.04, which is below the threshold of 0.05. Hence, it is evident that there is a statistically significant correlation between these two parameters. The value of Cramer's V is recorded as 0.518, indicating a very strong relationship between the severity of mould and respiratory problems. This phenomenon can be elaborated further as when individuals observe little patches of mould, they have minimal or negligible health effects. However, when they experience widespread mould growth, they tend to exhibit more severe health complaints. The similar finding has been documented in several prior researches, including Barnes *et al.*, 2022, Eeckhout *et al.*, 2013, and Moon and Yoon, 2010.

Household habits have a direct impact on respiratory problems. Smoking, in particular, is a significant habit that affects respiratory health. Based on the survey results, the calculated p-value for the relationship between smoking and respiratory issues is 0.001, which is lower than the significance level of 0.05. Therefore, it can be concluded that there is a statistically significant relationship between smoking and respiratory problems. The value of Cramer's V is 0.560, which indicates a highly significant correlation between smoking and respiratory symptoms. The same conclusion has been recorded in other previous studies, such as Tantisuwat and Thaveeratitham, 2014, and Cui *et al.*, 2010.

Based on the previously discussed interpretation, the variables that have a statistically significant impact on respiratory symptoms are the presence of household mould, the extent of mould, and smoking habits. Upon analysing and comparing Cramer's V statistic, it is clear that the smoking habit exhibits the strongest correlation with respiratory difficulties among these three factors. The association between mould extent and symptoms can be ranked second, while the presence of mould can be considered as the third factor.

4.2. Discussion

The purpose of this discussion is to critically evaluate and illustrate the results that were reported in the previous data analysis section, focusing on the research objective that was established at the beginning of the study. This section presents an expanded description of the factors that influence the growth of household mould, as well as the health problems associated with mould, based on the data obtained from the survey and statistical calculations. The discussion will also address the limitations of the study, such as methodological limitations and the applicability of the findings, presenting a balanced view of the research results. This study will provide strategies that will improve housing conditions, and increase knowledge of potential health risks associated with mould based on the research findings. Furthermore, it provides recommendations for public health initiatives and policy measures designed to decrease the growth of household mould and mitigate its health consequences in Bristol. Finally, this discussion will include suggestions for future research, proposing particular topics that could enhance the understanding of the complex relationships between household mould and health issues.

When reviewing the questionnaire, the first section related to the personal details of the individual. It is crucial to assess whether these personal information and other related parameters have an impact on the health symptoms reported by the respondents. Based on the results and data analysis, there is no statistically significant association between any of these variables and the respiratory health problem. Several reasons could be used to explain this lack of statistical significance of personal information. Identifying significant relationships between variables is more difficult when the sample size is small, which reduces the statistical power of the study. Since this study concerned only 50 individuals, it may be one reason for the difficulty in identifying a statistically significant relationship between personal information and health effects. Additionally, the survey's collection of personal information may not include all the relevant aspects of the respondents' lives that influence health outcomes. For instance, the survey primarily includes basic demographic information while ignoring specifics regarding lifestyle, stress levels, or genetic factors. Hence, the analysis may not completely capture every aspect of the relationship between personal characteristics and health.

The second segment of the questionnaire was focused on household details. It is important to take into account the property's characteristics in order to identify the factors that influence the formation of mould. The data analysis focused on key factors such as the type of dwelling, housing tenure, presence of pets, frequency of ventilation, and presence of moisture sources. Among these factors, only the frequency of ventilation and the presence of moisture sources were shown statistically significant correlations in relation to the growth of household mould. Furthermore, presence of moisture sources has stronger relationship with mould growth than the frequency of ventilation based on the comparison of Cramer's V statistics.

The ventilation frequency was assessed at various intervals, including multiple times per day, daily, weekly, and rarely. The findings indicated that ventilation many times per day resulted in the presence of only small patches of mould, while infrequent ventilation led to excessive growth of mould. To gather more information about the source of moisture, a targeted question (question number 7) was included to the questionnaire. This question included several sources such as leaking pipes, roof leaks, window condensation, and poorly sealed doors/windows. Respondents were told to answer whether they observed any of these sources. When considering the survey results, it is clear that poorly sealed doors and windows are the most common source of moisture compared to the other sources included in the survey.

In addition to these household characteristics, it is crucial to pay attention to the household habits of participants. Firstly, the smoking habit was examined since there was several previous studies reporting that smoking has a significant impact on respiratory problems (Tantisuwat and Thaveeratitham, 2014; Cui *et al.*, 2010). The current study also concluded that there is a strong statistically significant relationship between smoking and respiratory problems by proving those statements. When analysing the Cramer's V statistics it is clear that smoking habit showed the strongest relationship with respiratory issues than the other factors. In the context of household habits, the literature indicates that the most prevalent causes of household mould growth are the failure to use extractor fans in the kitchen, the failure to use extractor fans in the bathroom, and the drying of clothes indoors (Moon and Yoon, 2010). Consequently, these facts were incorporated into the survey, and a significant number of respondents (28 individuals) reported that they do not use extractor fans in their bathrooms. Additionally, a small number of respondents (11 individuals) mentioned that they are drying their clothes indoors. Further, two participants mentioned in the comment section, that they used to do drying cloths inside only in the winter season.

Another critical factor in the management of household mould growth is the implementation of regular maintenance (Evans and Kantrowitz, 2002). However, the current study did not show any significant relationship between maintenance and mould growth. 94 % of participants have indicated that they are not conducting routine maintenance in the survey. Numerous factors may contribute to householders in Bristol neglecting regular maintenance to control mould growth. Bristol is a city with a relatively high cost of living, which can result in residents having limited financial resources for property maintenance. It is possible that some residents are unaware of the health risks or the long-term harm that mould may cause on their property. Another common reason is that property owners and tenants may be uncertain about who is responsible for performing maintenance in rented properties. Renters may be less likely to invest in the maintenance of a property that they do not own or plan to rent for a long time. Some homeowners may postpone maintenance duties until the mould issue becomes more severe, at which point it becomes more difficult and costly to resolve.

The mould growth and extent were the main concerns of the third section of the questionnaire. The majority of participants (78%) have reported that they experience mould in their domestic environment. Further, respondents pointed out bathrooms and kitchens as the most prevalent locations for mould accumulation in their houses. Mould may grow in bathrooms because of the higher humidity levels generated by showers, baths, and sinks. In addition, kitchens are prone to have higher humidity levels as a result of the use of appliances such as dishwashers, heating water, and cooking. The warm, moist air in these places creates an ideal environment for mould spores to settle and develop. Bathrooms and kitchens are frequently affected from inadequate ventilation, particularly in older Bristol homes with tiny windows or extractor fans that are either absent or insufficient. This inadequate ventilation results in the retention of moisture in the atmosphere, which facilitates the proliferation of mould (Kempton *et al.*, 2022). In order to obtain a more comprehensive understanding of the attributes of mould, certain characteristics of mouldy areas were investigated, including musty smells, peeling paint, staining or discoloration, and material warping. Many of the people who contributed to the survey have reported that they have experienced these issues in the areas of mould present.

The fourth section of the survey included questions regarding the health symptoms. The most prevalent health issue in mouldy houses is respiratory issues, which are caused by various factors. Mould reproduces by spreading tiny particles into the atmosphere. The residents of a mouldy home can readily inhale these microscopic spores. Then they can cause a variety of respiratory issues by irritating the respiratory system after being inhaled. In addition, many people are allergic to mould spores. When these spores are inhaled, they can trigger allergic reactions, which often manifest as respiratory symptoms such as sneezing, coughing, wheezing, and shortness of breath (Mendell *et al.*, 2011). According to the survey, 68% of the respondents reported that at least one household member is experiencing this type of respiratory issue. Based on the analysis of the current study's findings, the variables that have a statistically significant influence on respiratory symptoms are the existence of household mould, the magnitude of mould, and smoking behaviours. Hence, when dealing with respiratory problems, these variables should be considered.

Aside from respiratory issues, further health problems have been reviewed, such as eye irritation, skin rashes, headaches or migraines, nausea or vomiting, and any other neurological symptoms. Only a few people responded to this question, with 12 reporting skin irritations, 8 reporting headaches or migraines, and only two reporting eye irritation. Others did not answer this question, hence it was not considered for statistical analysis. Furthermore, the medications used by the participants for respiratory difficulties were evaluated. However, only four people stated that they are taking medication for respiratory problems.

The fifth section of the survey included preventive measures and remediation for the growth of household mould. According to the data analysis, there is a strong correlation between taking preventative measures and presence of household mould. This indicates that when people take adequate preventive measures to reduce mould, there was a little or no mould formation could be observed. In order to determine the preventative measures that individuals have taken in their daily life, an additional question was included. This question includes measures such as enhancing ventilation, applying mould-resistant paints, obtaining expert assistance for mould treatment, using mould removers for cleaning, and repairing any leaks or sources of moisture. When analysing the survey responses, it is clear that the most prevalent measures used by the general population include improving ventilation and fixing any leaks or sources of moisture. Only a small number of participants (11) said that they have been using mould-resistant paints and applying mould removers for cleaning, other than the above methods.

In addition, participants were requested to give feedback on the effectiveness of their preventive measures. Based on the survey findings, the majority of those measures revealed a slight to moderate level of effectiveness. Moreover, the survey aimed at determining the challenges that individuals have in preventing or removing household mould, including insufficient understanding of mould removal techniques, financial limitations, time limits, and unsuccessful prior attempts. Among those time constraints and ineffective previous efforts are the most common answers given by participants.

The survey's ending section had an additional comment area where participants could freely express any views or concerns they had about household mould. A small number of participants (only 4) stated here that mould development is seasonal and that they are observing increased mould growth during the winter season. In addition, two individuals noted that during winter, ventilation is restricted in order to conserve heat inside the houses. Consequently, the growth of mould is increased in these winter months. This point is essential for studying since several previous studies have indicated that the growth of mould is influenced by the changing of the seasons (Nasir and Colbeck, 2012; Garrett *et al.*, 2012). During the winter months, limited ventilation and increased indoor humidity create a favourable setting for the proliferation of mould. In addition, in the winter season, people tend to spend more time indoors, leading to an increase in activities that introduce moisture into the air, such as cooking and bathing. Further, two participants mentioned here that they are drying cloths inside the houses only in the winter months. This research study was done throughout the months of July and August, which correspond to the summer season in Bristol. Hence, the findings of this study may differ if this was conducted during the winter season.

Although this research provides significant information on the presence of household mould and related health concerns in Bristol, UK, it is important to highlight several limitations of the study. One of the primary limitations of this research study was the sample size and its ability to accurately represent the Bristol population. As a result of difficulties in finding participants, the sample of the study may not accurately represent the complete range of residences in Bristol. This research was carried out throughout certain areas of Bristol, which might limit the relevance of the findings to the entire city. Hence, the conclusions obtained from this study may not be entirely relevant to communities that were not represented in the research. Expanding the geographic area covered would have provided a more detailed representation of the mould problems in different regions of Bristol. The temporal distribution of data collection throughout several months might influence the level of variability observed in the results. If the study conducted during the winter season, the outcomes would be changed, as explained above. These fluctuations in seasons may result in an underestimation of the occurrence and intensity of mould.

In addition, the limitations on data collection were imposed by ethical considerations and the necessity to safeguard participant privacy. Ethical considerations are especially important because of the sensitive nature of this topic, which intersects with personal information, issues of health, privacy, and housing conditions. The survey was conducted in a manner that showed respect and avoided any form of interference. Participants were guaranteed that their houses would not be evaluated or disclosed to any external parties, which is essential for those who may be concerned about potential consequences from property owners or municipal authorities. The research maintained high ethical standards by obtaining informed consent, safeguarding privacy, minimizing damage, ethically dealing with results, and considering people with disabilities. All of these efforts contributed an essential part in maintaining the trust of participants and the integrity of the research process, thereby improving the effectiveness of the study.

The outcomes and conclusion of this research on household mould in Bristol emphasize significant concerns regarding the widespread distribution of mould in residential settings and its possible consequences for public health. Hence, it is necessary to implement appropriate public health interventions and policy measures to efficiently address this problem in all of its aspects. The most important strategy for minimizing the growth of mould in households is to enhance public knowledge regarding its sources, health risks, and preventative techniques. These awareness programmes should include a clear explanation of the mould development process, the factors that lead to its proliferation, and the potential negative health effects associated with prolonged exposure. In addition, it is important to emphasize the correlation between mould and respiratory problems, especially among vulnerable groups including children, elderly people, and persons with pre-existing health conditions.

It is important to provide proper awareness about efficient methods for preventing mould, such as maintaining enough ventilation, managing the interior humidity levels, immediately repairing leaks, and using construction materials that are resistant to mould. Further, it is important to give practical guidance on simple and inexpensive measures, such as regularly ventilating rooms by opening windows and ensuring sufficient insulation. The awareness should also incorporate instructions on how to identify the early signs of mould proliferation and the appropriate measures that are needed for prevention. In order to successfully reach a wide range of people, it is important to distribute this guidance through several platforms, such as local media outlets, social media platforms, community centres, schools, and healthcare professionals.

Mould proliferation is frequently caused by basic housing quality problems, especially in poorly maintained properties. Therefore, it has become essential to improve housing regulations and standards in order to reduce the potential risks associated with mould. In addition, Bristol's building rules have to be modified to incorporate specific requirements for mould protection in both new buildings and renovations. This may include ensuring the use of materials that are resistant to mould, mandating the presence of adequate ventilation systems in kitchens and bathrooms, and requiring comprehensive controls for moisture and mould before issuing approval for building plans. Conducting regular checks of rental properties may help to detect and resolve problems before they worsen. Property owners should be responsible for ensuring that their rental properties comply with minimal requirements for mould prevention and should be responsible if they fail to do so. Strict implementation of penalties for non-compliance is necessary to ensure that property owners fulfil their duties with the maximum attention. In order to encourage renters and home owners to enhance the mould resistance of their homes, the local government could offer incentives financially. These include grants, low-interest loans, or tax rebates for performing repairs and improvements that effectively prevent the formation of mould. This is particularly important in low-income areas where property owners may lack of financial resources to carry out essential renovations.

Particular attention should be given to mould prevention and repair activities in social housing, where the most vulnerable individuals live in those houses. Public health authorities should collaborate with housing agencies to facilitate regular inspections of social housing units and promptly resolve any issues related to mould. The local government has the ability to create programs that provide financial assistance or completely cover the cost of mould remediation for low-income homes. Furthermore, collaborating with private sector businesses to provide discounted prices for mould remediation and house repairs might further reduce the financial burden on households. Healthcare professionals in Bristol require training in order to identify symptoms associated with mould exposure, including as respiratory problems, and to question possible mould exposure in patients' residences.

An implementation of a referral system is necessary that allows healthcare practitioners to guide patients with health issues associated to mould towards suitable housing or environmental health services. Implementing policies focused on enhancing access to inexpensive housing, such as the expansion of social housing initiatives and the regulation of the private rental sector would effectively reduce the occurrence of mould issues in these vulnerable communities.

There is a potential escalation in the risk of mould proliferation within residential properties due to the on-going impact of climate change on weather patterns. To reduce these risk factors, it is beneficial to implement climate adaptation measures, such as enhancing urban drainage systems, expanding green areas to absorb excessive moisture, and promoting the utilization of climate-resilient construction materials. Conducting workshops and training sessions for nearby communities would help residents with the knowledge and skills necessary to avoid and handle mould issues in their homes. The training sessions may include topics such as mould identification, efficient cleaning methods, and an awareness of the residents' rights regarding home conditions. Establishing localized support networks or community organizations that specifically address housing and health concerns may provide people with continuous assistance and access to resources for managing mould-related problems. These networks might be enabling communities to speak about their issues and collaborate to improve the housing conditions in their community. Fuel poverty also contributes to mould issues by reducing people's potential to effectively heat their houses. Policy measures should be implemented to enhance the availability of energy efficiency programs, such as the offering of grants or interest-free loans for insulation and heating system modifications.

On-going studies and the collection of data are essential for monitoring the efficacy of mould prevention measures and for determining future policy decisions. Bristol City Council has the potential to implement a monitoring programme aimed at tracking the presence of mould in different parts of the city. Data gathering may be performed by doing regular property inspections, analysing health data, and conducting surveys within the local areas. The results would be helpful in identifying locations with high risk and facilitate more efficient planning of prevention measures. Furthermore, it is essential to allocate resources for research studies specifically investigating the correlations between mould exposure and health consequences, with a special focus on vulnerable groups. Engaging in partnerships with universities, public health authorities, and housing groups has the potential to provide useful data that may be used in determining future policy decisions. It is recommended to establish an open-access database that analyses mould reports, health impacts, and housing conditions throughout the city. This will improve the transparency of residents, policymakers, and researchers, as well as enable the identification of mould growth patterns in the city with accurate statistics.

Previous research studies have shown a correlation between exposure to mould and a range of health consequences conducted in the UK. However, there are still significant gaps in recognising every aspect of mould's impact on human health and its relationship with housing conditions, socioeconomic variables, and local climates in specific areas such as Bristol. It is essential to focus on researches in these areas in order to establish effective public health programs and housing policies. There are limited statistical data sources regarding the impacts of mould exposure on the health of Bristol's citizens, especially those who are more vulnerable to adverse consequences. Further comprehensive research studies are required to investigate the specific impact of socioeconomic and environmental factors on the presence of mould in Bristol households. Moreover, the efficacy of current policies and interventions that are designed to prevent or remediate mould in Bristol homes needs to be more accurately assessed. Further research studies are needed to assess whether these measures are adequately protecting residents' health.

It is recommended that future research studies should concentrate on the conduct of long-term investigations that monitor the health effects of residents exposed to mould throughout the year. Furthermore, it is important that researchers analyse whether prolonged exposure to mould results in chronic health issues, including long-term respiratory problems. Additionally, it should consider other potential confounding factors, including occupational exposures and pollution. A mixed-methods approach by integrating qualitative data from interviews and quantitative data on mould levels and health outcomes, would offer an in-depth understanding of the successes and difficulties existing in current interventions. To prepare for future risks, research studies should design on how climate change could affect mould growth in Bristol homes and the subsequent health risks. Following that, studies should use modelling techniques to analyse the potential impact of various climatic scenarios on the proliferation of mould in residential properties across Bristol. These studies will help to identify which areas of the city are most vulnerable to climate-related mould risks and which housing types or conditions are particularly at risk.

Although the majority of studies on mould exposure primarily examine its effects on physical health, there is an increasing awareness of the psychological consequences associated with staying in mould-infested environments (Liddell and Guiney, 2015). Future research need to investigate the potential correlation between living in environments containing mould and the development of mental health conditions, such as stress, anxiety, and depression. In addition, researchers could investigate the efficacy of modern construction materials, such as mould-resistant drywall or paints, and the impact of smart home technologies on the monitoring and regulation of indoor humidity levels. Policymakers and public health officials can more effectively ensure the health and well-being of Bristol's residents, particularly those who are most vulnerable to the adverse consequences of mould exposure, by addressing these research gaps.

5.0. Chapter 5: Conclusion

People in the United Kingdom experience a number of challenges that are associated with their household settings. Among these issues, one of the most frequent concerns of homeowners and renters is the presence of mould and related problems. The presence and development of household mould are influenced by a variety of factors. Those can be highlighted as factors of household properties, environmental factors, social factors, and behavioural factors of people who live in those houses. Exposure to household mould has been associated with several adverse health consequences, particularly respiratory issues. Household mould is a persistent and expanding public health issue in Bristol, UK, with significant concerns for the health and welfare of the residents. The major purpose of this study was to comprehensively examine the factors affecting household mould development and assess its associated negative health effects on its residents in the city of Bristol. This research project was designed to collect data through a research questionnaire. The data gathered from this survey was analysed with IBM SPSS software. Frequency analysis was used to evaluate the participants' responses to specific questions. Correlation analysis was performed to identify the correlations between different variables associated with mould development and health symptoms. According to the Pearson Chi-square tests analysis, three factors have a significant relationship with the presence of household mould. Those are the availability of moisture sources (P value was 0.001), frequency of ventilation (P value was 0.048), and conducting preventive measures (P value was 0.001). Further, the presence of moisture sources has the most significant correlation with mould growth among these three factors according to the comparison of Cramer's V statistics; 0.593, 0.196 and 0.514 respectively. Similar tests were done to determine the correlations between respiratory symptoms and other relevant factors. Among the other factors, the presence of household mould (P value was 0.02), the extent of mould (P value was 0.04), and households' smoking habits (P value was 0.001) are the only variables identified to have a statistically significant impact on respiratory symptoms. Further, smoking habit showed the strongest relationship with respiratory issues from these three variables according to the Cramer's V statistics; 0.395, 0.518 and 0.56 respectively. Based on the survey findings and data analysis, several recommendations have been proposed to aware the general public and other relevant authorities in Bristol city. Although this research provides significant information on the presence of household mould and related health concerns in Bristol, UK, the study had several limitations. Further comprehensive research studies are required to full-fill the research gap on the presence of mould and related health effects in Bristol households.

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Appendix 01

Mould-Related Health Issues Questionnaire

This questionnaire aims to collect detailed information on individuals' exposure to mold and the related health issues they experience. The data gathered can be used to identify patterns, assess risks, and develop strategies for mitigating the impact of mold on health.

Section 1: Personal Information

1. Age: 18-30 ☐ 30-45 ☐ 45-60 ☐ 60-75 ☐ 75+ ☐
2. Gender: Male ☐ Female ☐ Other ☐
3. Ethnic Group:
 - White ☐
 - Asian or Asian British ☐
 - Black, Black British, Caribbean or African ☐
 - Mixed or other ethnic group ☐
4. Educational Background
 - Primary education ☐
 - Secondary education (GCSEs or equivalent) ☐
 - Further education (A-levels, BTECs, or equivalent) ☐
 - Higher education (Bachelor's degree) ☐
 - Postgraduate education (Master's degree, PhD) ☐

Section 2: Household Information

1. Type of house:

• Terraced House ☐	• Flats ☐
• Semi-Detached House ☐	• Apartments ☐
• Detached House ☐	• Other ☐
2. Housing Tenure: Owner-occupied ☐ Rented ☐ Social housing ☐
3. Number of People Living in the Household:.....
4. Do you have pets? Yes ☐ No ☐
5. How often do you ventilate your home?

• Many times per day ☐	• Once per day ☐
• Weekly ☐	• Rarely ☐

6. Do you have any of the moisture sources in your home?

Yes ☐ No ☐ Unsure ☐

7. What are the moisture sources you observe in your home? (Check all that apply)

- Leaking pipes ☐
- Roof leaks ☐
- Window condensation ☐
- Poorly sealed doors/windows ☐
- Other (please specify):

8. Are you smoking inside the home? Yes ☐ No ☐

9. Do you have any of the following habits at your home?(Check all that apply)

- Drying clothes indoors ☐
- Not using extractor fans in bathrooms ☐
- Not using extractor fans in the kitchen ☐

10. Do you perform regular maintenance on your home? Yes ☐ No ☐

Section 3: Mold Presence and Extent

1. Have you noticed any visible mold in your home? Yes ☐ No ☐ ☐
Unsure

2. If yes, where is the mold primarily located?(Check all that apply)

- Bathroom ☐
- Kitchen ☐
- Bedroom ☐
- Living room ☐
- Basement ☐
- Other (please specify):

3. How extensive is the mold growth?

- Small patches ☐
- Moderate coverage ☐
- Extensive coverage ☐

4. Have you experienced any of the following in mold-affected areas? (Check all that apply)

- Musty odors ☐
- Peeling paint ☐
- Staining or discoloration ☐
- Warping of materials ☐
- Other (please specify):.....

Section 4: Health Symptoms

1. Do any household members have breathing issues (e.g., coughing, wheezing, shortness of breath)

Yes ☐ No ☐

2. Do any household members experience any of the following symptoms? (Check all that apply)

- Eye irritation (e.g., redness, itching, watery eyes) ☐
- Skin rashes or irritation ☐
- Headaches or migraines ☐
- Nausea or vomiting ☐
- Neurological symptoms (e.g., memory loss, dizziness) ☐
- Other (please specify):.....

3. Are you currently taking any medication? Yes ☐ No ☐

4. If yes, please list the medications:.....

Section 5: Preventive Measures and Remediation

1. Have you taken any preventive measures to control mould?

Yes ☐ No ☐

2. What measures have you taken to address mold growth? (Check all that apply)

- Increased ventilation (e.g., opening windows, using exhaust fans) ☐
- Mold-resistant paints ☐
- Professional mold remediation ☐
- Cleaning with mold removers ☐
- Fixing leaks and moisture sources ☐
- Other (please specify):
.....

3. How effective were these measures in reducing or eliminating mold?

- Very effective ☐
- Moderately effective ☐
- Slightly effective ☐
- Not effective ☐

4. What challenges do you face in preventing or removing mould in your home?

(Check all that apply)

- Lack of knowledge on how to remove mold ☐
- Financial constraints ☐
- Time constraints ☐
- Ineffective previous efforts ☐
- Other (please specify):

.....

Section 6: Additional Comments

1. Is there anything else you would like to share about your household's mold issues or efforts to prevent mold growth?

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2. Would you be willing to participate in a follow-up interview or provide additional information if needed? Yes ☐ No ☐

Thank you for taking the time to complete this questionnaire. Your responses are invaluable to me and will greatly contribute to my Master's research project.

I appreciate your participation and feedback.