MICAT
Multiple Impacts Calculation Tool

Empirical basis of Social Impacts Avoided Burden of Asthma

Chun Xia-Bauer & Nora Mzavanadze
Wuppertal Institute

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 101000132.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 101000132.

Executive Summary

According to the European Union Statistics on Income and Living Conditions (EU-SILC), in 2021, almost 17% of the total population in the EU27 countries lived in a dwelling with a leaking roof, damp walls, floors or foundation, or rot in window frames or floors (Eurostat, 2022). A large number of studies conducted across many geographical regions show that there is a consistent association between indoor dampness/mould and asthma cases. Energy efficiency retrofits in residential housing can reduce indoor dampness to different extents and thus, potentially, asthma.

The multiple impact (MI) indicator is avoided burden of asthma due to the reduced exposure to indoor dampness over a certain time period as a result of energy efficiency improvements in the residential building sector. The standard method for assessing the Environmental Burden of Disease (EBD) is applied (Murray and Lopez, 2017). Since asthma can be attributed not only to dampness but also to many other factors, a key step of quantification is to attribute the share of current asthma prevalence to the exposure to dampness. The population attributable fraction (PAF) is an indicator that represents the proportion of the total disease burden that can be ascribed to a specified risk factor among many others (Braubach *et al.*, 2011). The PAF of asthma due to exposure to indoor dampness is a function of the population living in buildings with high dampness, which is projected by the MICAT energy poverty model.

MICAT

Multiple Impacts Calculation Tool

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 101000132.

Scope of MI Indicator

Definition

The indicator measures avoided burden of asthma due to the reduced exposure to indoor dampness in the EU, a given EU member country, or a city over a certain period due to energy efficiency improvements in the residential building sector.

Asthma: "Asthma is a long-term condition affecting children and adults. The air passages in the lungs become narrow due to inflammation and tightening of the muscles around the small airways, which leads to the following symptoms: cough, wheeze, shortness of breath and chest tightness" (WHO, 2021).

Mould: "all species of microscopic fungi that grow in the form of multicellular filaments" (WHO, 2009).

Dampness: "any visible and measurable outcome of excess moisture that causes problems in buildings, such as mould, leaks or material degradation, mould odour or directly measured excess moisture (in terms of relative humidity or moisture content) or microbial growth" (WHO, 2009).

Thus, dampness is a prerequisite for the growth of mould.

Health effects of dampness/mould: A large number of studies conducted across many geographical regions show that there is a consistent association between indoor dampness/mould and asthma (including both children and adults) (Braubach *et al.*, 2011).

Relevance on EU, national and/or local level

According to the European Union Statistics on Income and Living Conditions (EU-SILC), in 2021, almost 17% of the total population in the EU27 countries lived in a dwelling with a leaking roof, damp walls, floors or foundation, or rot in window frames or floor (Eurostat, 2022). Indoor dampness can lead to mould growth; exposure to mould can result in a health problem – asthma.

Impact pathway figure

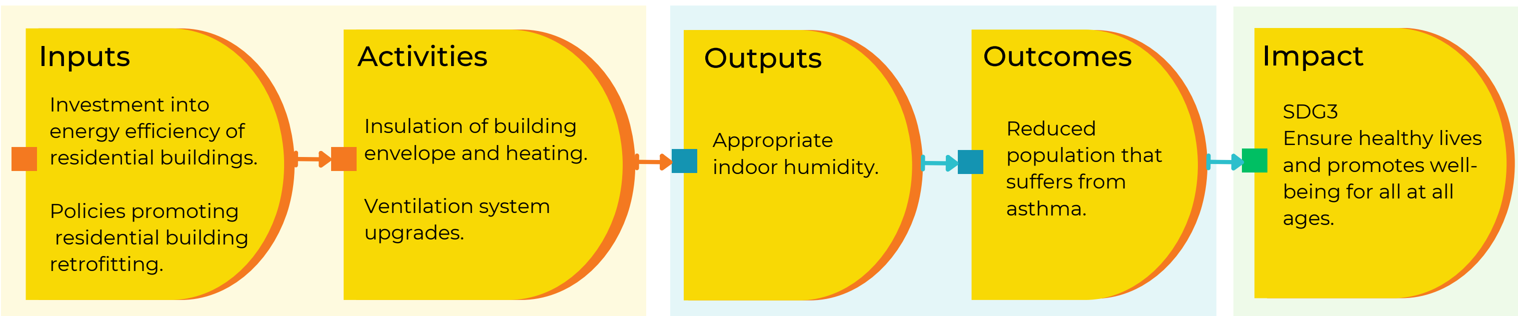

Figure 1 : Logic model (theory of change) for avoided burden of asthma due to the reduced exposure to indoor dampness

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 101000132.

Quantification method

Overlaps with other MI indicators and potential risk of double-counting

A lower number of asthma cases may reduce public budget spent on public health services. However, to which extent it reduces public budget spending in this regard varies, depending on the health insurance system, financing sources of public health system, and setup of welfare state institutions in a specific country, etc. In addition, fewer cases of asthma lead to lower absenteeism among employees, which can lead to higher productivity for companies, and thus affect other macroeconomic variables positively. However, these interaction effects cannot be reliably quantified within MICAT and are thus not taken into account.

Description

The standard method for assessing the Environmental Burden of Disease (EBD) is applied to quantify the impact on asthma due to indoor dampness (Murray & Lopez, 2017). Burden of disease quantifies the extent of a specific disease in the population. Burden of disease measured in disability-adjusted life years (DALYs), a unit of measurement that includes both mortality and morbidity aspects One DALY represents the loss of the equivalent of one year of full health. "Environmental" includes environmental risks and other factors, such as work environment or poverty, that cause diseases (Pruss-Ustun *et al.*, 2003).

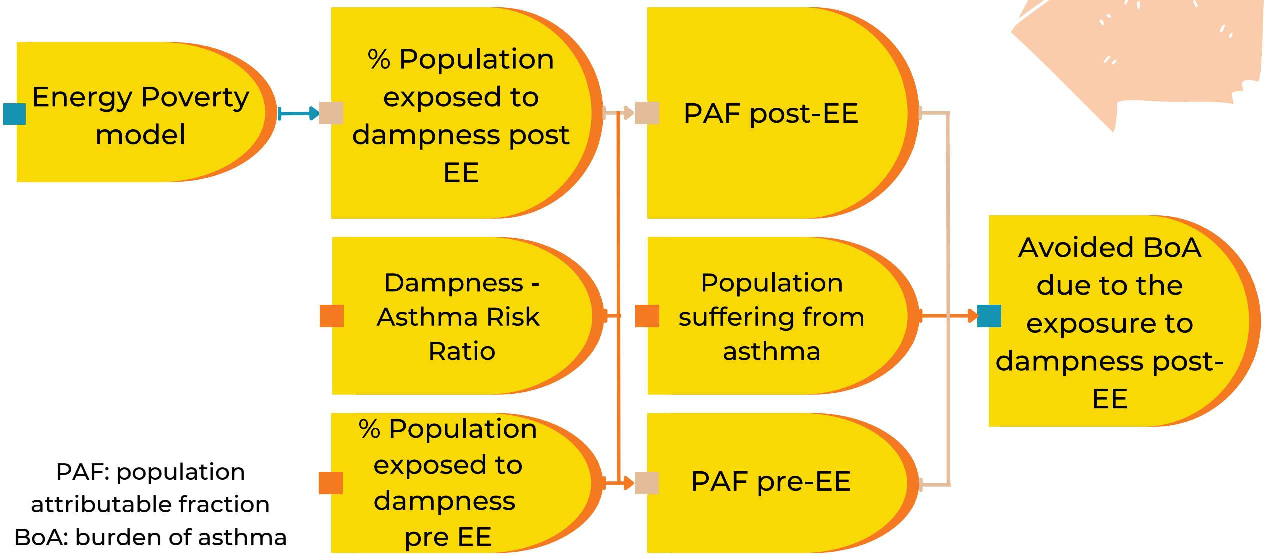

Figure 2: Main calculation steps

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 101000132.

Asthma can be caused not only by dampness, but also by many other factors. Thus, a pivotal step to quantify the impacts of energy efficiency measures on asthma morbidity is to attribute the share of current asthma prevalence to the exposure to dampness in a given population. The population attributable fraction (PAF) represents the proportion of the total disease burden ascribed to a specified risk factor among many others (Braubach et al., 2011). In the context of indoor dampness in housing and asthma, PAF represents the proportion of the total asthma disease burden that will be prevented if exposure to dampness is removed:

$$PAF_c = \frac{PDc \times (RR-1)}{PDc \times (RR-1)+1}$$

Where PDc = proportion of the population exposed (to dampness) in a specific country, and RR is the relative risk for the condition in those exposed.

For the current PDc value for the EU-27 countries, we adopt the indicator from the EU-SILC data „the total population living in a dwelling with a leaking roof, damp walls, floors or foundation, or rot in window frames or floor" (Eurostat, 2022). The estimation of the relative risk (RR) in scientific literature varies due to different types of exposure definitions (water damage, dampness, and mould), different climate conditions, and the age of participants (Quansah *et al.*, 2012; Mzavanadze, 2018). Since PDc is based on the EU SILC's indicator, which only includes the exposure to water damage and dampness without mould, the quantification should adopt RR estimate observed only for indoor dampness. Thus, MICAT uses an estimated RR that considers asthma as a result of exposure to dampness. The value (1.3) was derived from a review of 40 cross-sectional studies by Urlaub and Grün (2016).

As a consequence, the asthma disease burden attributable to exposure to dampness in a specific country (AEBDAc) is calculated as follows:

$$AEBDAc = PAFc \cdot EBDAc$$

EBDA: total environmental disease burden of asthma

Methodological challenges

One major methodology challenge is associated with data uncertainty:

- Uncertainty associated with the relative risk (RR) estimates for asthma onset in relation to exposure to dampness. Ideally, RR should be specific to different climate zones and different age groups (Mzavanadze, 2018).
- Uncertainty associated with the data on the prevalence of asthma among the general population of EU member states. According to the European Health Interview Survey (EHIS), the data is based on self-assessment, not officially reported medical diagnoses (Steppuhn *et al.*, 2017). The former is self-reported based on asthma symptoms, such as wheezing, chest tightness, breathlessness, and coughing. However, many other respiratory conditions lead to similar respiratory symptoms. Thus, symptoms-based self-assessment may lead to considerable misclassification and underreporting or overreporting (Braubach et al., 2011).
- Uncertainty of indoor air exchange technologies applied in renovations. Deep renovation technologies without adequate ventilation solutions might create indoor dampness problems in places where they did not exist.

MICAT

Multiple Impacts Calculation Tool

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 101000132.

Data requirements

- Input data from scenarios/policy measures evaluations
  - Population exposed to dampness projected from the energy poverty model

- External data sources used for quantification
  - Total population
  - Population exposed to dampness:
    National level: the total population living in a dwelling with a leaking roof, damp walls, floors or foundation, or rot in window frames or floors (ILC_MDES01).
    City level: downscaling from national data or based on surveys in cities
  - EBD asthma
    National level: Global Burden of Disease Study database: https://vizhub.healthdata.org/gbd results/.
    City/local level: downscaling from national data above or based on survey in cities

- Assumptions taken
  - The study assumes that removing a trigger that causes asthma (indoor dampness) would also eliminate asthma morbidity cases.
  - The same relative risk (RR) estimate is applied for all EU member countries and for the general population (not specific for age groups); the RR stays the same throughout the projection period.
  - The EDB stays the same throughout the projection period.

Impact factor/functional relationship

$$\Delta AEBDA_c = \Delta PAF_c \cdot EBDA_c$$

ΔAEBDAc : the reduced burden of asthma attributable to exposure to dampness in a specific country
ΔPAFc: the change of the population attributable fraction (PAFc)

The population attributable fraction (PAFc) is a country/city-specific impact factor. The PAFc is a function of the proportion of the population exposed (to dampness) in a specific country (PDc). The projection of PDc is implemented in the projection of the energy poverty indicator.

Monetization

The valuation of health benefits, such as the potential to reduce excess mortality, can be based on a) market values (e.g., average cost in the health care system of treating an illness, medication costs, lost productivity due to sick days) and/or b) non-market values based on surveys to determine the value of a statistical life (VSL) or value of a life year (VOLY). The market value approach requires a systematic inquiry into the health care systems of specific countries. Since health care and associated welfare system varies greatly from country to country in the EU, the first approach is not practical for MICAT, the non-market values approach is applied. VSL represents the individual willingness to pay (WTP) for small changes in the likelihood of death in a specific period. It is not a value placed on preventing a death with certainty, which is often misinterpreted (Robinson et al., 2019).

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 101000132.

OECD (2011) recommends using VSL for the monetisation of health impacts related to air pollution. Other studies, e.g. Hurley *et al.* (2005) in Chiabai *et al.* (2018), argue that assigning a full statistical life for short-term exposure to air pollution, causing minor changes in death likelihood, might be exaggerating and suggest to use VOLY. However, little empirical research is available for VOLY.

Due to different stakeholder preferences with respect to monetisation, it is foreseen that users of the MICATool can choose between the two options. Option 1 follows the OECD's approach, where VSL is applied to monetise both premature mortality and asthma reduction. Option 2 adopts VOLY. This is particularly suitable if the population affected is predominantly elderly people. It represents a conservative approach, which is also recommended for multiple impact assessments of energy efficiency measures by Mzavanadze (2018).

The economic value of avoided burden of asthma due to the reduced exposure to indoor dampness (VAc) in a specific country is calculated as follow:

$$VAc = VOLYc \cdot \Delta AEBDAc$$

or

$$VAc = VSLc \cdot \Delta AEBDAc$$

VOLYc: value of a life year in a specific country

VSLc: the value of a statistical life in a specific country

ΔAEBDAc : the reduced burden of asthma attributable to exposure to dampness in a specific country.

Conclusion:

About one-sixth of the European population lives in buildings with leaking roofs, damp walls, floors or foundations. A large number of studies show that there is a consistent association between indoor dampness and asthma. While energy renovation could reduce dampness, renovations without adequate ventilation solutions might create in-door dampness problems. This indicator reflects the avoided burden of asthma due to a reduced exposure to indoor dampness caused by proper energy renovation. Besides, energy-poor households often live in damp houses. Thus, to assess the impacts of different levels of policy commitment to address energy-poor households, the indicator is calculated using the output of the energy poverty model.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 101000132.

References

- Braubach, M., Jacobs, D. E., Ormandy, D., World Health Organization, & Regional Office for Europe (2011). Environmental burden of disease associated with inadequate housing a method guide to the quantification of health effects of selected housing risks in the WHO European Region. Copenhagen: World Health Organization Regional Office for Europe.
- Chiabai, A., Spadaro, J.V. & Neumann, M.B.(2018). Valuing deaths or years of life lost? Economic benefits of avoided mortality from early heat warning systems. Mitig Adapt Strateg Glob Change 23, 1159–1176. https://doi.org/10.1007/s11027-017-9778-4
- Eurostat (2022). Total population living in a dwelling with a leaking roof, damp walls, floors or foundation, or rot in window frames or floor (ILC_MDHO01).
- Hurley F., Hunt A., Cowie H., Holland M., Miller B., Pye S., Watkiss P. (2005). Methodology for the cost-benefit analysis for CAFE: volume 2: health impact assessment. AEA Technology Environment, UK. Report to DG Environment of the European Commission. AEAT/ED51014/Methodology Volume 2 Issue 1
- Murray, C. J. L., & Lopez, A. D. (2017). Measuring global health: motivation and evolution of the Global Burden of Disease Study. The Lancet, 390(10100), 1460–1464. https://doi.org/10.1016/S0140-6736(17)32367-X
- OECD. (2011). Valuing Mortality Risk Reductions in Regulatory Analysis of Environmental, Health and Transport Policies: Policy Implications", OECD, Paris, www.oecd.org/env/policies/vsl
- Pruss-Ustun, A., Mathers, C., Corvalan, C., & Woodward, A. (2003). Assessing the environmental burden of disease at national and local levels: introduction and methods. Geneva: World Health Organization. http://public.eblib.com/choice/publicfullrecord.aspx?p=3050142
- Robinson, L., Hammitt, J., O'Keeffe, L. (2019). Valuing mortality risk reductions in global benefit-cost analysis. Journal of Benefit-Cost Analysis 10 (S1), 15-50, 2019
- Steppuhn, H., Kuhnert,R., and Scheidt-Nave,C. (2017). 12-month prevalence of asthma among adults in Germany. Journal of Health Monitoring2(3). doi.10.17886/RKI-GBE-2017-064
- Urlaub, S. and Grün, G. (2016). Mould and dampness in European homes and their impact on health. IBP-Report EER-058/2016/950.
- World Health Organization (WHO) (2009). WHO guidelines for indoor air quality: dampness and mould. https://www.euro.who.int/__data/assets/pdf_file/0017/43325/E92645.pdf
- World Health Organization (WHO) (2021). Asthma. https://www.who.int/news-room/fact-sheets/detail/asthma