
Certificate in Health Impact Assessment (United Kingdom)

Environmental Health Impact Assessment

Health Impact Assessment (HIA) is a systematic process that combines scientific evidence, community values, and stakeholder perspectives to predict the potential effects of a policy, program, or project on the health of a population. In the context of environmental health, the focus is on how changes in the physical environment—air, water, soil, noise, and built infrastructure—may influence health outcomes such as respiratory disease, cardiovascular conditions, mental wellbeing, and health inequalities. The aim is not only to identify adverse effects but also to propose measures that can enhance positive health impacts and reduce harms before decisions are finalised.

The core vocabulary of environmental HIA is extensive, and mastery of each term enables practitioners to conduct robust assessments, communicate findings effectively, and influence decision-making. Below is a comprehensive explanation of the most frequently encountered terms, illustrated with practical examples and discussion of typical challenges.

Screening is the initial step that determines whether a proposed action warrants a full HIA. Screening tools range from simple checklists to more sophisticated decision-trees. For instance, a local council considering a new bypass may use a screening questionnaire that asks whether the project will alter traffic volume, generate additional pollutants, or affect vulnerable populations. If the answer is yes to any of these, a full HIA is recommended. A common challenge at this stage is the tendency of decision-makers to skip screening due to time pressures, potentially overlooking significant health effects.

Scoping defines the boundaries of the assessment. It clarifies which health outcomes, populations, and geographic areas will be examined, and it establishes the methods and resources required. During scoping, practitioners engage with stakeholders to identify concerns and priorities. For example, when assessing a proposed waste-to-energy plant, scoping may identify respiratory health, cancer risk, and community anxiety as key outcomes, and it may set the assessment radius at 5 kilometres based on prevailing wind patterns. A frequent difficulty in scoping is balancing breadth and depth; overly broad scopes can dilute focus, while too narrow scopes may miss important indirect effects.

Baseline assessment involves collecting data on the existing health status, environmental conditions, and social determinants before the project commences. This provides a reference point to which future changes can be compared. Baseline data may include hospital admission records for asthma, ambient air quality measurements, demographic statistics, and surveys on community wellbeing. The quality of baseline data directly influences the reliability of the HIA. In many cases, baseline data are incomplete or outdated, requiring practitioners to use proxy indicators or modelled estimates, which introduces uncertainty.

Exposure assessment quantifies the magnitude, frequency, and duration of contact between the population and environmental hazards. It distinguishes between different pathways—air inhalation, water ingestion, soil contact, and noise exposure. For a new road, exposure assessment would calculate the increase in nitrogen dioxide (NO₂) concentrations at residential addresses, the number of minutes residents spend outdoors, and

the proportion of children who attend schools near the road. Tools such as dispersion models, geographic information systems (GIS), and personal monitoring devices are commonly employed. A typical challenge is accounting for variability in individual behaviour, such as time-activity patterns, which can lead to over- or under-estimation of exposure.

Determinants of health are the factors that influence health outcomes, ranging from biological and behavioural to social and environmental. In environmental HIA, the focus is on the environmental determinants—air quality, water quality, noise, temperature, and built environment features. Understanding how these determinants interact with social determinants (e.g., Socioeconomic status, housing quality) is essential for assessing equity impacts. An example is the interplay between poor air quality and low-income housing, where residents may be more vulnerable due to pre-existing health conditions and limited access to healthcare.

Risk assessment evaluates the probability and severity of adverse health effects resulting from exposure. It typically follows the four-step framework of hazard identification, dose-response assessment, exposure assessment, and risk characterisation. For a proposed industrial facility, risk assessment would identify the hazardous chemicals released, determine the relationship between dose and health effect (e.g., The increased risk of lung cancer per $\mu\text{g}/\text{m}^3$ of benzene), assess exposure levels for nearby residents, and finally characterise the overall risk. One of the main challenges is the scarcity of dose-response data for many emerging contaminants, which necessitates the use of precautionary assumptions.

Stakeholder analysis identifies individuals, groups, and organisations that have an interest in or are affected by the proposed action. Stakeholders may include local residents, community groups, public health agencies, environmental NGOs, developers, and regulators. The analysis maps their influence, concerns, and potential contributions to the HIA process. Engaging stakeholders early and throughout the assessment improves relevance and acceptance of findings. However, divergent interests and power imbalances often create conflict, requiring skilled facilitation and transparent communication.

Community participation is a cornerstone of HIA, ensuring that local knowledge, values, and priorities shape the assessment. Participation can take many forms: Public meetings, focus groups, surveys, citizen science, and participatory mapping. For instance, residents near a proposed wind farm might be invited to map perceived visual impacts and report any sleep disturbances, providing data that complement technical measurements. A recurring challenge is achieving meaningful participation rather than tokenistic consultation, especially when community capacity is limited.

Qualitative methods such as interviews, focus groups, and document analysis capture non-numeric information about perceptions, values, and lived experiences. These methods are valuable for exploring issues like mental health impacts, sense of place, and community cohesion—areas that are difficult to quantify. In a HIA of a new shopping centre, qualitative data might reveal concerns about increased traffic noise affecting local schools, or feelings of loss among long-time residents. The limitation of qualitative methods lies in their subjectivity and difficulty in integrating findings with quantitative results.

Quantitative methods involve the use of numerical data, statistical analysis, and modelling to estimate health impacts. Common techniques include epidemiological risk modelling, cost-benefit analysis, and

health impact modelling software such as the WHO's Health Impact Assessment Toolkit. Quantitative approaches enable the estimation of excess cases of disease, disability-adjusted life years (DALYs), and monetary valuation of health outcomes. A major challenge is the need for high-quality data and the assumptions embedded in models, which can affect the credibility of the results.

Cumulative impact assessment examines the combined effect of multiple stressors over time and space. It recognises that populations are often exposed to a mixture of pollutants and social pressures that may interact synergistically. For example, a community living near a highway, an industrial park, and a busy port may experience cumulative exposure to particulate matter, heavy metals, and noise, leading to amplified health risks. Assessing cumulative impacts requires integrated data sets and sophisticated modelling, and it is frequently constrained by data availability and methodological complexity.

Equity analysis evaluates how health impacts are distributed across different social groups, such as by age, gender, ethnicity, income, or disability status. Environmental HIA aims to identify and mitigate disproportionate burdens on vulnerable populations. In a HIA of a new housing development, equity analysis might reveal that low-income families are more likely to be allocated to the portion of the site with higher flood risk, prompting recommendations for equitable allocation of safe housing. A persistent challenge is the lack of disaggregated data, which can mask hidden inequalities.

Mitigation measures are actions proposed to reduce or prevent adverse health impacts identified in the assessment. They can be technical (e.G., Installing scrubbers on a factory), administrative (e.G., Implementing traffic management plans), or behavioural (e.G., Promoting active travel). For a proposed urban redevelopment, mitigation may include creating green spaces to offset loss of natural habitats, enhancing pedestrian pathways to encourage walking, and implementing noise barriers to protect nearby schools. The effectiveness of mitigation depends on proper design, implementation, and monitoring.

Monitoring and evaluation (M&E) is the systematic tracking of health outcomes and environmental indicators after the implementation of a project, to verify whether predicted impacts have materialised and whether mitigation measures are working. M&E plans specify indicators (e.G., Ambient NO₂ levels, asthma hospital admissions), data sources, frequency of measurement, and responsible parties. An example of M&E is the post-construction air quality monitoring around a new motorway, coupled with health surveillance of local residents. Challenges in M&E include securing long-term funding, maintaining data quality, and attributing observed changes directly to the project amid other influencing factors.

Reporting involves communicating the HIA findings to decision-makers, stakeholders, and the wider public. Reports should be clear, transparent, and accessible, summarising methodology, assumptions, results, uncertainties, and recommendations. Visual tools such as maps, charts, and infographics help convey complex information. In the UK, HIA reports often follow the guidance set out by the National Institute for Health Research (NIHR) and may be submitted to planning authorities as part of the planning application dossier. A frequent pitfall is the production of overly technical reports that are not easily understood by non-specialists, reducing the impact of the assessment.

Regulatory context in the United Kingdom provides the legal and policy framework within which environmental HIA operates. Key statutes include the Environmental Protection Act 1990, the Health and

Safety at Work Act 1974, and the Planning Act 2008. While HIA is not mandated by law for all projects, it is strongly encouraged under the National Planning Policy Framework (NPPF) and the Public Health Outcomes Framework. Understanding the interplay between HIA and Environmental Impact Assessment (EIA) is essential; often, a joint HIA/EIA approach is adopted to streamline processes. Practitioners must navigate multiple agencies—Local Authority, Public Health England, Environment Agency—and align HIA recommendations with statutory requirements, which can be complex and time-consuming.

Environmental impact assessment (EIA) is a related but distinct process that assesses the effects of a project on the natural environment, including air, water, biodiversity, and landscape. When combined with HIA, the assessment gains a holistic perspective on both ecological and health outcomes. For example, a new railway line may be evaluated for its impact on wildlife corridors (EIA) and on local residents' exposure to noise and air pollutants (HIA). Integration challenges include reconciling different methodological standards, timelines, and reporting formats.

Health determinants framework is a conceptual model that categorises the various factors influencing health. The WHO's Social Determinants of Health framework, for instance, groups determinants into structural (e.g., Policies, socioeconomic position) and intermediate (e.g., Material circumstances, behaviours) levels. In environmental HIA, the framework guides the identification of indirect pathways—such as how a new retail park may increase traffic, leading to higher air pollution, which in turn elevates respiratory disease risk. Using a framework helps ensure that assessments do not focus narrowly on direct exposures but also consider broader systemic influences.

Risk communication refers to the exchange of information about health risks between experts and the public. Effective risk communication is transparent, timely, and tailored to the audience's level of understanding. In the case of a proposed chemical plant, risk communicators must explain complex toxicological data in plain language, address community concerns, and provide clear actions that can be taken to reduce risk. Challenges include managing misinformation, building trust, and dealing with emotional responses that may influence risk perception.

Precautionary principle is a policy approach that advocates taking protective action in the face of uncertainty, rather than waiting for conclusive scientific proof of harm. In environmental HIA, the precautionary principle may justify stricter exposure limits or the adoption of mitigation measures even when evidence of adverse health effects is limited. For example, if a new pesticide's long-term health effects are not fully understood, the precautionary approach would recommend limiting its use near residential areas. Critics argue that excessive precaution can hinder development, but the principle remains a cornerstone of public health protection.

Cost-benefit analysis (CBA) quantifies the economic value of health impacts and mitigation measures, enabling comparison with project costs. Health benefits can be monetised using willingness-to-pay, value of a statistical life (VSL), or cost-of-illness approaches. In a HIA of a new urban park, CBA might assign a monetary value to reduced cardiovascular disease due to increased physical activity, offsetting the project's construction costs. A major limitation of CBA is the ethical debate surrounding the valuation of human life and health, as well as the uncertainty inherent in assigning monetary values to intangible benefits such as mental wellbeing.

Health economic evaluation expands on CBA by incorporating methods such as cost-effectiveness analysis (CEA) and cost-utility analysis (CUA). These techniques compare the cost per health outcome achieved (e.G., Cost per quality-adjusted life year gained). When assessing a traffic-calming scheme, a CEA could compare the cost of installing speed bumps with the reduction in road-traffic injuries. Health economic evaluations provide decision-makers with evidence on the efficiency of interventions, but they require robust data on both costs and health outcomes, which are not always available.

Data sources for environmental HIA are diverse. Primary data may be collected through field measurements (e.G., Air sampling), surveys, and interviews. Secondary data include national health statistics, environmental monitoring networks, land-use maps, census data, and previous research studies. The UK offers rich data repositories such as the Office for National Statistics (ONS), Public Health England's Fingertips platform, and the Department for Environment, Food & Rural Affairs (DEFRA) air quality database. However, data gaps often arise at fine spatial scales, necessitating interpolation or the use of proxy variables, which can introduce uncertainty.

Uncertainty analysis examines the degree of confidence in the assessment's results, identifying sources of variability and potential bias. Techniques include sensitivity analysis, scenario modelling, and Monte Carlo simulation. For a HIA of a proposed landfill, uncertainty analysis might explore how different assumptions about leachate composition affect predicted groundwater contamination levels. Communicating uncertainty transparently is essential to maintain credibility, yet many practitioners find it difficult to convey technical uncertainty without undermining the perceived authority of the assessment.

Scenario planning involves developing alternative future conditions to explore how different decisions or external factors could influence health outcomes. Scenarios may vary in terms of policy choices, technological developments, or demographic trends. In a HIA of a coastal development, scenarios could include sea-level rise trajectories, changes in tourism patterns, and implementation of green infrastructure. Scenario planning helps decision-makers understand trade-offs and fosters resilient, adaptive strategies. The main difficulty lies in selecting plausible scenarios and avoiding speculation that may dilute the focus of the assessment.

Health surveillance is the systematic collection, analysis, and interpretation of health data to monitor trends over time. In the context of HIA, surveillance data can be used as baseline indicators and for post-implementation monitoring. For example, hospital episode statistics (HES) on respiratory admissions can be tracked before and after a new industrial site becomes operational. Limitations include lag times in data availability and the inability to attribute changes to a single cause when multiple factors influence health trends.

Participatory GIS (Geographic Information System) integrates spatial data with community input, allowing stakeholders to map perceived hazards, valued assets, and health concerns. In a HIA of a new housing estate, residents might use participatory GIS to identify areas of high noise annoyance, locations of green spaces, and routes they consider unsafe. The resulting maps can be overlaid with technical exposure models to identify hotspots where mitigation is most needed. Challenges include ensuring that participants have the necessary technical skills and that the maps are accurately georeferenced.

Environmental justice refers to the fair distribution of environmental benefits and burdens across all social groups. In HIA, environmental justice analysis assesses whether certain communities—often those already disadvantaged—are disproportionately exposed to hazards. A classic case is the siting of a power station in a low-income neighbourhood, leading to higher rates of asthma among children. Addressing environmental justice may involve redistributive measures, such as relocating vulnerable populations, providing health services, or enhancing community infrastructure. The main obstacle is the entrenched nature of structural inequalities, which may require broader policy reforms beyond the scope of a single HIA.

Health equity focuses on the attainment of the highest possible standard of health for all people, regardless of social position. HIA seeks to promote health equity by identifying differential impacts and recommending actions that reduce disparities. For a new public transport scheme, equity analysis may highlight that low-income neighbourhoods have limited access to stations, suggesting the need for subsidised fares or additional routes. A difficulty is that equity considerations often clash with economic or political priorities, demanding careful negotiation and advocacy.

Stakeholder engagement strategy outlines the plan for involving different groups throughout the HIA process. It specifies objectives, methods, timelines, and responsibilities. An effective strategy may combine public meetings, targeted workshops for vulnerable groups, online surveys, and a stakeholder advisory panel. The strategy should also address conflict resolution mechanisms and feedback loops to ensure that stakeholder input is reflected in the final report. Common problems include stakeholder fatigue, low attendance at meetings, and the dominance of vocal interest groups that may marginalise quieter voices.

Health impact pathways describe the sequence of events linking an environmental change to a health outcome. They include exposure, biological effect, and health consequence. For example, a pathway for noise from a construction site may be: Increased ambient noise → sleep disturbance → elevated stress hormones → increased risk of hypertension. Mapping pathways helps identify points where interventions can be most effective. Complexity arises when multiple pathways intersect, such as when air pollution and noise together influence cardiovascular risk, requiring integrated analysis.

Indicator selection involves choosing measurable variables that reflect health outcomes, exposure levels, or determinants. Indicators should be relevant, reliable, and sensitive to change. Common health indicators in environmental HIA include incidence of asthma, rates of cardiovascular disease, premature mortality, and mental health scores. Environmental indicators might be PM_{2.5} Concentration, noise level (dB(A)), and water quality parameters (e.g., Nitrate concentration). Selecting appropriate indicators is often constrained by data availability and the need to balance comprehensiveness with practicality.

Temporal dimension considers the timing of impacts, distinguishing between short-term, medium-term, and long-term effects. A HIA of a construction project may anticipate immediate impacts such as dust generation, medium-term impacts like changes in traffic patterns, and long-term impacts such as altered land-use patterns influencing chronic disease risk. Temporal analysis assists in planning monitoring schedules and in predicting when mitigation measures should be implemented. One challenge is forecasting long-term impacts accurately, especially when future socioeconomic conditions are uncertain.

Spatial dimension addresses the geographic distribution of impacts. It involves defining the study area,

delineating exposure zones, and mapping health outcomes. GIS tools enable the visualisation of exposure gradients, hotspot identification, and the overlay of demographic data. Spatial analysis is crucial for identifying vulnerable sub-populations, such as children living within 200 metres of a major road. Limitations include the Modifiable Areal Unit Problem (MAUP), which can affect statistical results depending on how boundaries are drawn.

Health risk threshold is a predefined level of exposure or risk at which action is considered necessary. Thresholds may be set by regulatory bodies (e.G., The UK's Air Quality Standards) or by policy objectives. In HIA, thresholds guide the interpretation of results: If predicted NO₂ levels exceed the legal limit, mitigation is mandatory; if they remain below, mitigation may be optional. Determining appropriate thresholds can be contentious, especially when scientific evidence is evolving or when political considerations influence acceptable risk levels.

Environmental monitoring involves systematic measurement of environmental parameters (e.G., Pollutants, noise, temperature) before, during, and after project implementation. Monitoring data provide empirical evidence to validate modelling predictions and to assess compliance with standards. For a new airport expansion, continuous monitoring of aircraft noise and ambient ozone can be required by the planning permission. Challenges include the cost of monitoring equipment, the need for specialised expertise, and the potential for data gaps during critical periods.

Health outcome mapping visually represents the spatial distribution of health data, facilitating the identification of clusters and patterns. Mapping can reveal, for example, higher rates of chronic obstructive pulmonary disease (COPD) in areas downwind of an industrial zone. Such visual tools are powerful for communicating findings to non-technical audiences and for supporting targeted interventions. However, privacy concerns may restrict the level of detail that can be displayed, especially when dealing with small population groups.

Exposure gradient describes how exposure intensity changes with distance or other variables. In many environmental HIA scenarios, exposure diminishes with increasing distance from the source. Understanding gradients helps to define the spatial extent of the assessment and to identify zones where mitigation can be most effective. For instance, a 10-metre increase in distance from a busy road may correspond to a measurable reduction in particulate matter exposure. Accurately characterising gradients requires high-resolution data and robust modelling techniques.

Health disparity refers to the difference in health status between groups that is avoidable and unjust. HIA aims to uncover health disparities that arise from environmental changes, such as increased asthma rates among children in a low-income neighbourhood after a new factory is built. Addressing disparities often involves targeted interventions, policy changes, and community empowerment. The challenge lies in disentangling environmental contributions from other social determinants that also drive disparities.

Data triangulation is the practice of using multiple data sources or methods to cross-validate findings. In environmental HIA, triangulation may involve combining air quality model outputs, personal exposure measurements, and self-reported health surveys to strengthen confidence in exposure-response relationships. Triangulation reduces reliance on a single data set, thereby enhancing robustness. Yet,

integrating disparate data types can be methodologically demanding and may require advanced statistical expertise.

Health impact modelling employs mathematical or simulation models to estimate health outcomes based on exposure data. Models such as the Air Quality Health Impact Assessment (AQHIA) tool, the WHO's Integrated Environmental Health Impact Model (IEHIM), or bespoke regression models are commonly used. These models translate changes in pollutant concentrations into expected numbers of hospital admissions, premature deaths, or DALYs. Model selection depends on the availability of input data, the health outcomes of interest, and the required level of precision. Model uncertainty, parameter selection, and validation are key challenges.

Policy relevance assesses the extent to which HIA findings inform or influence policy decisions. A HIA that produces actionable recommendations aligned with existing policy objectives (e.g., The UK's Clean Air Strategy) is more likely to be taken up. Demonstrating policy relevance often requires clear linkage between assessment results and policy levers, such as planning conditions, zoning regulations, or public health interventions. Practitioners must be adept at framing results in a way that resonates with decision-makers' priorities.

Implementation plan outlines how the recommendations of the HIA will be put into practice. It specifies tasks, responsible parties, timelines, resources, and performance indicators. For a HIA of a new sports complex, the implementation plan might include installing air filtration systems, creating a community health outreach program, and scheduling periodic noise assessments. A common obstacle is the lack of enforceable mechanisms to ensure that recommendations are acted upon, particularly when the HIA is voluntary.

Legal liability concerns the potential for legal action if a project causes health harm that could have been foreseen and mitigated. In the UK, the duty of care established under the Health and Safety at Work Act may extend to environmental exposures, and failure to conduct a thorough HIA could be interpreted as negligence. While most HIAs are conducted to reduce liability risk, practitioners must be aware of the legal implications of their findings and recommendations.

Ethical considerations encompass principles such as fairness, transparency, respect for autonomy, and beneficence. Ethical dilemmas may arise when balancing economic development against health protection, or when dealing with conflicting stakeholder interests. For example, a proposal to build a new logistics hub may promise job creation but also raise concerns about increased diesel emissions. Ethical practice requires documenting the decision-making process, acknowledging uncertainties, and ensuring that vulnerable groups are not disproportionately burdened.

Capacity building refers to strengthening the skills, knowledge, and resources of individuals and organisations involved in HIA. Training workshops, mentorship programmes, and the development of guidance documents are typical capacity-building activities. In the UK, universities, public health agencies, and professional bodies often collaborate to deliver HIA training for planners, environmental consultants, and community advocates. A persistent challenge is maintaining expertise over time, especially when funding for HIA projects is limited.

Interdisciplinary collaboration is essential because environmental HIA draws on expertise from epidemiology, environmental science, urban planning, sociology, economics, and law. Effective collaboration requires clear communication, shared terminology, and mutual respect for differing disciplinary perspectives. In practice, an interdisciplinary team might include an epidemiologist modelling disease risk, a GIS specialist mapping exposure, a planner designing mitigation measures, and a community liaison facilitating stakeholder engagement. Coordination difficulties, such as differing timelines and methodological preferences, can hinder progress if not managed proactively.

Data governance addresses the policies and procedures that ensure data are managed responsibly, securely, and ethically. This includes considerations of data ownership, consent, confidentiality, and compliance with regulations such as the UK General Data Protection Regulation (GDPR). When using health records for baseline assessment, practitioners must obtain appropriate approvals, anonymise data, and store it securely. Failure to adhere to data governance standards can jeopardise public trust and result in legal repercussions.

Adaptive management is a structured, iterative approach to decision-making that incorporates learning from monitoring results to adjust strategies over time. In environmental HIA, adaptive management may involve revising mitigation measures based on observed changes in air quality or community health. For example, if post-implementation monitoring reveals higher than expected noise levels, additional sound barriers could be installed. The adaptive cycle requires flexibility in contracts, budget provisions for modifications, and a governance framework that supports ongoing evaluation.

Health surveillance systems such as the UK's Syndromic Surveillance Programme provide near-real-time data on disease trends, which can be valuable for detecting early health impacts after a project begins. By linking surveillance data with exposure information, practitioners can identify spikes in respiratory symptoms that may be linked to construction activities. However, surveillance systems often capture only broad categories of illness, limiting the ability to attribute specific causes.

Public health impact assessment (PHIA) is a term sometimes used interchangeably with HIA, though it can emphasise broader public health outcomes, including health promotion and disease prevention strategies. In the UK, PHIA may be required for major policy reforms, such as changes to the national transport strategy, where the focus extends beyond environmental exposures to include lifestyle changes, access to services, and social cohesion.

Environmental health risk assessment (EHRA) is a specialised form of risk assessment that focuses on environmental hazards and their health implications. EHRA typically involves a detailed chemical analysis, toxicological assessment, and exposure modelling. In a HIA, EHRA may be conducted for specific contaminants of concern, such as heavy metals from a former industrial site. The integration of EHRA findings into the broader HIA narrative ensures that technical risk insights are translated into actionable health recommendations.

Health impact statement is a concise document summarising the key health findings of an HIA, often required as part of a planning application. It includes a summary of methods, main health impacts, mitigation recommendations, and monitoring plans. The statement must be clear, jargon-free, and tailored

to the audience of planners and elected officials. Crafting an effective health impact statement demands distilling complex analyses into essential messages without oversimplifying.

Stakeholder mapping is the visual representation of stakeholder relationships, influence, and interest levels. It helps prioritise engagement efforts and identify potential allies or opponents. For a HIA of a new renewable energy farm, mapping may reveal that local environmental groups have high interest but low influence, whereas the regional development agency has high influence. Strategies can then be devised to empower interested but less influential groups, perhaps through co-design workshops.

Health impact pathways diagram is a visual tool that illustrates the sequence from environmental change to health outcome, including mediating factors. It aids communication with non-technical audiences and clarifies where interventions can be inserted. In a HIA of a new public park, the diagram might show: Increased green space → reduced urban heat island effect → lower heat-related morbidity → improved overall wellbeing. Developing such diagrams requires interdisciplinary input to capture all relevant links.

Environmental health surveillance focuses on monitoring environmental parameters that have direct health relevance, such as concentrations of lead in drinking water or levels of particulate matter. Surveillance data are essential for establishing trends, identifying emerging hazards, and informing early-warning systems. In a HIA, environmental health surveillance can be used to validate modelled exposure estimates and to trigger rapid response actions if thresholds are exceeded.

Health equity audit is a systematic review that assesses whether health impacts and mitigation measures are distributed equitably across population groups. The audit may use equity indicators such as the proportion of low-income households benefiting from a mitigation measure. Findings from the audit inform recommendations to adjust implementation plans to improve fairness. Conducting an audit can be challenging when disaggregated data are not readily available.

Social impact assessment (SIA) examines how a project influences social structures, community cohesion, cultural values, and quality of life. While SIA is distinct from HIA, the two are often integrated because social changes can affect health. For example, a new shopping centre may alter local employment patterns, impacting mental health through changes in economic security. Integrating SIA findings into HIA ensures a holistic understanding of the project's consequences.

Health impact indicator is a specific metric used to track changes in health status over time. Indicators may be incidence rates, prevalence, mortality, or composite measures such as the Index of Multiple Deprivation (IMD) health domain. Selecting robust indicators is critical for monitoring the effectiveness of mitigation measures. However, health indicators can be influenced by many factors beyond the project, making attribution challenging.

Exposure modelling is the computational process of estimating pollutant concentrations at specific locations based on emission sources, meteorological data, and terrain characteristics. Common models include AERMOD for air dispersion, CALPUFF for complex terrain, and the Noise Assessment Model (NAM) for sound propagation. Accurate exposure modelling requires high-quality input data and expertise in model configuration. Errors in input parameters, such as emission rates, can propagate through the model

and affect risk estimates.

Health impact assessment framework provides a structured approach that guides practitioners through the stages of HIA. In the UK, the framework recommended by the National Health Service (NHS) includes screening, scoping, assessment, reporting, and monitoring. The framework also emphasises stakeholder engagement, equity analysis, and the integration of HIA with other assessment processes. Adhering to the framework promotes consistency, transparency, and comparability across assessments.

Policy linkage describes how HIA findings are connected to specific policy instruments, such as planning policies, health strategies, or environmental regulations. Demonstrating policy linkage enhances the relevance of HIA recommendations and facilitates their adoption. For example, a recommendation to improve pedestrian infrastructure can be linked to the UK's Sustainable Communities Plan. Identifying clear policy pathways, however, requires a deep understanding of the policy environment and proactive dialogue with policymakers.

Health impact mitigation hierarchy ranks mitigation options from most to least effective. The hierarchy typically follows the order: Avoid, minimise, compensate, and monitor. Avoidance involves altering the project design to eliminate exposure (e.G., Relocating a factory away from residential areas). Minimisation reduces exposure through engineering controls (e.G., Installing filters). Compensation provides benefits to offset impacts (e.G., Creating a community health centre). Monitoring ensures that mitigation measures are effective. Applying the hierarchy can be constrained by project constraints, cost considerations, and stakeholder preferences.

Environmental health indicator tracks environmental conditions that have direct implications for health, such as ambient particulate matter levels, waterborne pathogen counts, or noise levels measured in decibels. Selecting appropriate indicators aligns with the health outcomes of interest and the regulatory thresholds. For a HIA of a new airport runway, the key environmental health indicators might include NO₂ concentrations, PM₁₀ levels, and night-time noise levels. Indicator selection must also consider data availability and measurement feasibility.

Health impact appraisal is the analytical phase where potential health effects are quantified, qualified, and interpreted. It integrates exposure assessment, risk assessment, and equity analysis to produce an overall picture of health impacts. The appraisal may produce a matrix summarising the magnitude of impact (e.G., Negligible, moderate, high) for each health outcome. Conducting a thorough appraisal requires interdisciplinary expertise and often involves iterative refinement as new data emerge.

Mitigation implementation monitoring tracks the progress and effectiveness of mitigation actions. It involves setting performance targets (e.G., Achieve 30% reduction in PM_{2.5}), Measuring outcomes, and reporting to stakeholders. For air quality mitigation, monitoring may include periodic ambient air sampling at fixed stations. The data are compared against baseline levels to assess whether the mitigation is delivering the intended health benefits. Challenges include maintaining consistent monitoring protocols and ensuring that data are promptly acted upon.

Health impact communication plan outlines how findings will be disseminated to different audiences, the

timing of communications, and the channels to be used (e.G., Public meetings, newsletters, websites). Effective communication enhances transparency, builds trust, and facilitates stakeholder participation. The plan should tailor messages to the needs and literacy levels of each audience, using plain language and visual aids where appropriate. A common pitfall is under-communicating uncertainties, which can later erode credibility if unanticipated outcomes arise.

Risk perception refers to the way individuals interpret and respond to hazards, which may differ from scientific risk estimates. Factors influencing perception include personal experience, cultural beliefs, trust in authorities, and media coverage. In HIA, understanding risk perception helps shape communication strategies and identify areas where additional information or reassurance may be needed. For example, residents may perceive a new waste incinerator as a high risk despite low measured emissions, requiring targeted outreach to address concerns.

Health impact assessment toolbox comprises the set of methods, software, guidelines, and templates that practitioners use. Common tools include the HIA Toolkit (WHO), the UK's Health Impact Assessment Guidance, GIS software (e.G., ArcGIS, QGIS), statistical packages (e.G., R, Stata), and health impact models. The toolbox enables standardisation and efficiency, but practitioners must select tools appropriate to the context and ensure they have the technical capacity to apply them correctly.

Cost-effectiveness threshold is the maximum amount a decision-maker is willing to pay for a unit of health benefit (e.G., £30 000 Per QALY). In the UK, the National Institute for Health and Care Excellence (NICE) provides guidance on cost-effectiveness thresholds. When evaluating mitigation measures, comparing the cost per health outcome to the threshold helps prioritise interventions. However, thresholds can be controversial, and health benefits that are difficult to quantify (e.G., Mental wellbeing) may be undervalued.

Health impact assessment peer review involves independent experts evaluating the methodology, data, assumptions, and conclusions of an HIA. Peer review enhances scientific rigour, identifies potential biases, and improves credibility. The review may be formal (e.G., Through an academic journal) or informal (e.G., By a senior consultant). Ensuring that reviewers have appropriate expertise and that feedback is incorporated into the final report are essential steps.

Environmental health policy integration seeks to embed health considerations into broader environmental policies, ensuring that health is not an afterthought. In the UK, this integration is promoted through the Health and Environment Alliance and the National Health Service's commitment to "health in all policies." Successful integration requires cross-sector collaboration, shared objectives, and joint performance indicators. Institutional silos and competing priorities often impede integration efforts.

Health impact assessment audit is a systematic review of the HIA process itself, examining compliance with best-practice guidelines, the quality of data, stakeholder engagement, and the implementation of recommendations.