1. **Summary**

1.1 The Board wants to better understand the relative impacts of different food-related health conditions, as an input to the prioritisation of public health interventions alongside issues such as tractability and cost. The work presented here will be an important input into the way the Board sets its strategic priorities.

1.2 Economists and Operational Researchers at the FSA are working to estimate the burden of foodborne diseases and food hypersensitivity. We will have detailed outputs from this programme to share later in the year. In preparation, this paper explains the approach we have developed, the methodology used, and its potential application and current limitations.

1.3 Although the work described here represents a significant improvement from the model previously used to estimate the burden of foodborne disease, it remains an imperfect science. As we are using datasets from different periods and sources, comparators are not perfect and of course our understanding continues to develop as new science and evidence emerges. Therefore, this work provides a framework for fair comparisons, but expert and informed judgement will still be required to apply it when making strategic decisions.

1.4 The Board is asked to consider and confirm this approach to model the burden of foodborne illness and food hypersensitivity as an important input to setting strategic priorities in future.

2. **Introduction**

2.1 This paper describes the extensive programme of work undertaken to date by FSA economists and external experts to improve estimates of the burden of foodborne diseases (FBD) and to generate for the first-time analogous estimates of the burden of food hypersensitivities. Together, these form a significant proportion of the food safety related hazards that are of concern to the FSA (Figure 1). In parallel, FSA risk assessors are investigating risk prioritisation tools for risks related to chemical in foods and radiological contamination with the long-term objective of estimating their economic and societal burden and allowing the construction of an approach to impact assessments that cover all food-safety related hazards.
2.2 This programme of work uses a Cost of illness (COI) approach to identify and estimate the costs of a particular disease to society. This approach models the direct costs of treating the diseases as well as indirect costs such as productivity loss resulting from time off work. In addition to these financial and economic costs, the COI model we have developed includes the monetised costs of pain and suffering that individuals incur through a foodborne illness. COI analysis provides decision-makers with a perspective on the magnitude of the economic burden of a disease or condition, to which offers a perspective on the size of the issue. This can, in turn, improve our organisational capability in a number of areas (Figure 2). However, costs are only one part of the picture and cost-benefit analysis and cost-effectiveness analysis still are the main tools as a way of systematically assessing the costs and benefits of an intervention or comparing different interventions.
3. Evidence and Discussion

The COI model for Foodborne Disease

3.1 The FSA now has completed COI estimates for 13 individual pathogens (Figure 3), plus foodborne illness of unknown aetiology, which when aggregated provides a total UK FBD economic cost estimate. The COI model draws extensively on previously commissioned research and input from external experts from the University of Manchester, University of Liverpool, London School of Hygiene and Tropical Medicine, in addition to input from our scientific advisory committees, ACSS and ACMSF.

Figure 3: List of FBD pathogens covered by the Cost of Illness Model

3.2 Figure 4 illustrates the financial cost and non-financial cost components of the FSA COI model.

- Financial costs contain direct and indirect cost components:
  - Direct costs refer to medical care expenditures associated with diagnosis, treatment, management and other financial costs related to the illness i.e. resource use and costs to the NHS pertaining to visits to the GP, A&E and hospitalisations; including individual cost such as transportation and out of pocket expenses (prescription charges, over the counter purchases etc.)
  - Indirect costs include productivity losses due to illness for the affected individual including carers. The methodology underpinning these productivity loss estimates are consistent with the Health & Safety Executive (HSE) Cost to Britain model in estimating the impacts on human capital and the wider economy. The model has

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also been extended to reflect education loss for children, a feature not captured before.

- The non-financial component of the model accounts for the intangible valuation of the pain and suffering associated with an illness. Drawing from previously commissioned research\(^2\) FSA economists have applied a well-established method, willingness to pay (WTP), to estimate the payments people are willing to make to avoid getting ill. The WTP approach is based on the principle that how much people are willing to pay for a "good" can be its economic value. In this way a price can be proxied for those "goods" that do not have a market, such as "avoiding being ill". The WTP is a standard method used when appraising or evaluating whether a policy has an impact on health status and where a monetary value may need to be put on the associated change in quality of life; an approach which is consistent and in line with HM Treasury Green Book Guidance\(^3\).

**Figure 4: Components in the FSA COI model for FBD**

3.3 The modelling of direct and indirect financial costs relating to health care, personal expenses and productivity losses is informed by the FSA’s Foodborne Disease Estimation Model (FDEM)\(^4\), which provide estimates of the proportion and number of foodborne cases that result in presentations to a GP, hospitalisations and deaths. This is illustrated in Figure 5 below, using campylobacter as an example.

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\(^4\) FDEM model developed in-house by FSA Operational Researchers.
3.4 For the first time the FSA has also been able to produce economic cost estimates for food hypersensitivity, although these are currently partial estimates relating to instances of food hypersensitivity that lead to hospitalisation and/or death. The methodology underpinning these estimates is analogous to the COI approach and framework used for FBD cost estimates, as set out above.

**QALY for Foodborne Disease and Food Hypersensitivity**

3.5 A complementry approach to the COI model is provided by Quality Adjusted Life Years (QALYs). QALYs are an alternative non-monetised metric for prioritising individual pathogens and food hypersensitivities. QALYs are a generic measure of disease burden, which takes into account both the quantity and quality of life lived - measuring the quality of the remaining years of life for an individual (see figure 6 below).

3.6 QALYs are calculated by estimating the years of life remaining or loss for a patient following a particular intervention or event; and weighting each year with a quality-of-life score (on a 0 (death) to 1 (perfect health) scale). It is often measured in terms of the person’s ability to carry out the activities of daily life, and freedom from pain and mental disturbance.
QALYs are used across government and are in line with HM Treasury Green Book guidance on economic appraisal and evaluation. Pathogens, allergens, food intolerance and coeliac disease are measured and ranked in terms of QALY loss from the health conditions associated. These estimates are derived from commissioned published FSA research\(^5\).

4. Conclusions

**Current limitations and further work to refine the model**

4.1 Medical costs in the FBD COI model should be interpreted as lower bound costs. This is because financial costs attributed to long-term complications associated with potential chronic conditions (sequelae) have not been captured. Only the intangible element such as pain and suffering has been accounted for in the model using WTP values. Future work to enhance the associated long-term medical costs is devised, which will increase the robustness and consistency of the model.

4.2 Food hypersensitivity estimates from this partial COI model are indicative and do not reflect the overall burden to society as the number of cases relate only to those hospitalised. In addition, food intolerance estimates rely solely on lactose related cases - a proxy for lower bound total cost estimates of food intolerance cases. Furthermore, the preventive costs associated to food hypersensitivity - actions undertaken by individual to avoid having an allergic reaction, such as dietary restriction - are suspected to represent a high burden which the current

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\(^5\) FSA Study on the Use of Quality Adjusted Life Years for Food Safety Risks (Phase 1) (referred as QALY phase 1) [here](https://www.food.gov.uk/sites/default/files/media/document/fs102087p1finrep.pdf); and Estimating Quality Adjusted Life Years and Willingness to Pay Values for Microbiological Foodborne Disease (Phase 2) (referred as QALY phase 2) [here](https://www.food.gov.uk/research/meat-hygiene-research-programme/estimating-quality-adjusted-life-years-and-willingness-to-pay-values-for-microbiological-foodborne-disease-phase-2)
model does not account for. As a result, current estimates could represent a
significant lower bound of the potential economic burden due to food
hypersensitivity. In the coming months, work will be carried out (in-house and
commissioned) to better understand the overall impact of food hypersensitivity on
the sufferers’ daily life.

4.3 There is ongoing work with the London School of Hygiene & Tropical Medicine
(LSHTM) as we engage directly with health practitioners (GPs, hospital
consultants) to map out the patient journey with a view to eliciting primary data
on NHS resource use for FBD (at symptom level including long-term
complications) and food hypersensitivity cases. This work reflects ongoing
efforts to develop more granular and robust NHS cost burden estimates, which
take account direct medical costs associated with diagnosis, treatment,
medication and long-term complications (sequelae).

4.4 There are longer-term plans to commission research to address methodological
challenges into the valuation of the “maintenance” state such as dietary
management and avoidance of allergens for those suffering from food
hypersensitivity. However, more immediate work will look to elicit data on direct
personal financial costs associated with dietary management (special diet,
equipment or emergency management) and avoidance (time spent reviewing
food labelling, eating out and travel).

4.5 An indicative timeframe for this work is set out below in table 1.

<table>
<thead>
<tr>
<th>Table 1 - Future Work Programme on the COI for Foodborne Disease (FBD) and Food Hypersensitivity (FH)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Strand 1: Estimating financial healthcare cost for FBD and FH COI model</strong></td>
</tr>
<tr>
<td>1.1 Mapping out patient pathway to identify and quantify NHS resource use pertaining to FBD and FH cases driven by varying levels of severity (individuals accessing GPs and hospitals). In collaboration with LSHTM.</td>
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<tr>
<td>1.2 Cost framework in-house with a view to understanding undiagnosed food hypersensitivity cases i.e. behaviour, incentives and preferences of sufferers; applying relevant cost components.</td>
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<tr>
<td><strong>Strand 2: Produce financial cost estimations on maintenance state for FH</strong></td>
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<tr>
<td>2.1 Personal cost of managing food hypersensitivity risk on a daily basis. [Cost of special diet or equipment; time spent reviewing food labelling, eating out and travel; emergency management etc.]</td>
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<tr>
<td><strong>Strand 3: Produce WTP values and QALY for FH</strong></td>
</tr>
<tr>
<td>3.1 Estimating willingness-to-pay (WTP) values and quality adjusted life years (QALY) lost for food hypersensitivity. [Estimation and quantification of all health states associated with FH sufferers]</td>
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<tr>
<td>3.2 Estimating the WTP values and QALY lost for maintenance state of FH sufferers and their carers. [Assess and quantify the quality of life lost to FH sufferers (and their carers if applied) for managing food risks in their daily life.]</td>
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</tbody>
</table>
4.6 Cost of Illness outputs will allow us to estimate the economic burden associated to food risk, which is essential for understanding their social impacts. The COI model can therefore contribute to the FSA strategy process and, when combined with other relevant inputs and with expert and informed judgement, will inform priority setting. Furthermore, robust, reliable and up-to-date COI estimates would inform policy appraisals, cost-benefit and cost-effectiveness analysis in addition to establishing a baseline to track the realisation of benefits from policy interventions. Non-monetary metrics such as QALYs provide complementary and well-established metrics that account for associated health impacts and provide a broad assessment of impact on the wellbeing of individuals.

4.7 It is also important to highlight, that individual metrics should not be used on their own, but rather in conjunction with or as a composite suite of metrics to systematically construct weights for prioritisation measures that are fit for purpose in aiding both strategic development and policy design. Policy-makers should also take into account, if deemed relevant, public acceptability and consumer risk perception.