The socio-economic impacts of increased seafood consumption in England

Final Report
prepared for Seafish

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In collaboration with

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Foreword from the Seafood 2040 Programme

The primary objective of the Seafood 2040 Strategic Framework[1] (SF2040) is to encourage England's population to consume two portions of seafood per person per week[2]. The health benefits of seafood such as protein rich and low calorie are well documented. However, what is not clearly understood is the estimated socioeconomic value of the impact of increased seafood consumption on Government budgets, the economy, NHS, and the population. There is a lack of reliable data for evidence-based decision-making and planning. The delivery of this research was in response to Recommendation 6 of the Framework[3] asking whether is it possible to estimate the potential value to society (via health benefits to the economy) if people were to eat more seafood.

By what margin would there be positive economic impacts on future Government spending and NHS budgets not to mention social and economic impacts on population health if there was an increase in seafood consumption? Would it be a large enough reduction that would save a significant number of lives as well as reduce future Government and NHS money spent on ill health and obesity? What is the connection and impact between increased seafood consumption and Govt and NHS spend and population health?

The approach to the investigation utilised a novel method to provide estimates.

1. Determining the health benefits to be gained from improving seafood consumption from currently reported levels to the target levels of SF2040 of two portions of seafood per person, per week; and
2. Estimating the financial quantification those health benefits as subsequent costs to society that such dietary changes may support.

Overall, the research provides some insight into what potential scale of benefits of increased seafood consumption to consumers in England – as well as the UK – could be.

The SF2040 Seafood Industry Leadership Group (SILG), which oversee the SF2040 programme and commissioned this research, have learned a great deal from this work, but it should be understood that this was a pioneering study that involved an approach to a technically difficult question. Therefore, it is a preliminary piece of work that provides interesting early indications of potentially substantial health benefits from increased seafood consumption. There is a lot of science, data and information in the public domain and making sense of it all is quite challenging. However, this is not unusual when determining outcomes for nutritional interventions.

[1] https://www.seafish.org/document/?id=98F10916-276C-414C-84E7-F6870F9CD417

[2] https://www.nhs.uk/live-well/eat-well/fish-and-shellfish-nutrition/#:~:text=A%20healthy%2C%20balanced%20diet%20should,of%20many%20vitamins%20and%20minerals.

[3] Recommendation 6 is on page 28.

This preliminary study was independently peer reviewed by two researchers and is an important first step and useful as a platform on which to build future work. These findings are likely to be of great interest to the relevant policy makers, but the results warrant further investigation to check validity of methods, data and assumptions. Some potential substantial savings to government are clear, but equally there are other potential positive impacts that were not investigated in this study, such as the benefits of seafood consumption to cardiovascular health. Some omissions may have been the result of the way the research question was framed, and this needs to be looked at from the perspective of ensuring that such an analysis is as comprehensive as possible for all potential benefits of eating seafood, especially since those health benefits can be so wide-ranging. The SF2040 SILG therefore regards this work as interesting, but preliminary, and an important first step in addressing this key question.

Further research is now required to validate the results of the first study and determine methods for the inclusion of additional health conditions. Equally important is the opportunity to address not just mitigation of disease, but to bring into analysis an overview of wellness indicators that also investigate the possibility of increased seafood consumption on quality of life indicators. The SF2040 SILG will be taking both of these aspects forward within a revised Recommendation 6 for the Framework and aim to fund and commission the subsequent research in 2021 and 2022.

This work is at the nexus of government policy and the seafood industry. If the estimates are found to be robust there are implications for government policy, and in relation to initiatives such as the National Food Strategy and any upcoming government obesity strategy. For those directly or indirectly working within the seafood industry the nutritional benefits of consuming wild catch and farmed fish and shellfish are strongly implied and there are good data to back up this position. The greater challenge comes in providing robust assessments for the value of those benefits, and that is a goal that the SF2040 SILG are working towards.

Executive Summary

Background to the study

Risk & Policy Analysts (RPA) and Health Economics Consulting (HEC) at the University of East Anglia (UEA) were commissioned by the Seafood 2040 (SF2040) programme at the Sea Fish Industry Authority (Seafish[4]) to conduct this research. The programme was approved by the Fisheries Minister, George Eustice MP, in 2017 and is a shared strategy and action plan developed by stakeholders across the seafood supply chain to move England's seafood industry toward a thriving and sustainable future by 2040.

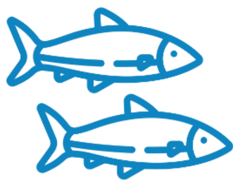
The study aims to show the health benefits of fish consumption and how these health benefits can be translated into net gains to the overall economy. This study also aims to assess the barriers and opportunities around seafood consumption growth.

Main findings

In a healthcare system faced with financial stress, diseases related to lifestyle such as cardiovascular disease and diabetes, have become increasingly concerning not only for the NHS, but also for the economy overall.

Diet is one of the modifiable factors that can influence susceptibility to such diseases. Eating a healthy diet can help to reduce obesity, which is believed to account for 80 to 85% of risk of Type 2 Diabetes (T2D) (Diabetes.co.uk, 2019[5]).

Eating a healthy diet can help to lose weight, reduce obesity, lower cholesterol levels and blood pressure and decrease the risk of type 2 diabetes



NHS guidelines recommend that 'a healthy, balanced diet should include at least two portions of fish a week, including one of oil rich fish'

Fish and shellfish are good sources of many vitamins and minerals. Oil rich fish – such as salmon and sardines – is also particularly high in long-chain omega-3 fatty acids, which can help to keep the heart healthy

The purpose of this research is to review available evidence on the population health and socio-economic benefits from increasing seafood consumption and determine the positive gains in population health and the potential reductions in government spend on ill-health as a result. Studies over several decades have suggested a link between fish consumption and reductions in ill-health. NHS guidelines recommend that '*a healthy, balanced diet should include at least two portions of fish*

[4]Seafish is a Non-Departmental Public Body (NDPB) set up to support the UK seafood industry.
[5]Diabetes.co.uk (2019): Diabetes and obesity, available at https://www.diabetes.co.uk/diabetes-and-obesity.html

a week, including one of oil rich fish' (NHS, 2019)[6]. However, household purchases of fish and fish products have fallen steadily since 2006 (Defra, 2018[7]). The current estimate for seafood consumption across England is half the recommended level, i.e. just over one portion a week (c. 140 g) (Defra, 2018).

A review of the potential benefit of fish consumption highlights that including fish in the diet produces several health benefits. These benefits stem mostly from weight control and reduced risk of being overweight, as fish is a lean source of protein with lower fat content.

The analysis suggests that the yearly socio-economic benefits from increasing seafood consumption are likely to far exceed the costs to the consumers from buying seafood. The benefits include both avoided NHS care costs and business savings from reduced work absenteeism. There will also be benefits to consumers linked to reduced ill-health and better quality of life. The benefits to individuals from reduced risk of ill-health (combined T2D and cancer) are valued between £80/week and £140/week respectively. The costs of buying seafood for an individual is not expected to exceed £1.70/week.

The net socio-economic impacts from increasing seafood consumption to one more additional portion a week across the English population can be valued at between £14.5m and £58.2m per week in benefits (from avoided cases of T2D and cancer).

Main health outcomes from increased seafood consumption

The literature has revealed that including fish in the diet produces several health benefits. The main health benefits from increased fish consumption as found in the literature are related to the Colorectal cancer; Lung cancer; Ovarian cancer; and T2D. The variation for specific health outcomes reflects some of the uncertainties with the modelling.

The largest impacts are expected to be in terms of reduced cases of T2D. These benefits stem mostly from weight control and reduced risk of being overweight, as fish is a lean source of protein with lower fat content, reducing also obesity. Obesity is believed to account for 80-85% of the risk of developing T2D, while recent research suggests that obese people are up to 80 times more likely to develop T2D than those with a BMI of less than 22 (Diabetes.co.uk, 2019[8]). The model used in this study takes account of BMI as a risk factor to develop T2D but the impacts due to this risk factor alone were not modelled separately to avoid double-counting. In other words, our modelling does take account of BMI as a risk factor of T2D too, but the contribution of obesity alone cannot be separated from others like physical activity, level of education, medical history, age, etc.

All cancers: 3,600 to 18,000 could be avoided per year if increasing seafood consumption to two portions a week (considering mortality rates, this will be equivalent to 1,700 to 8,500 lives saved).

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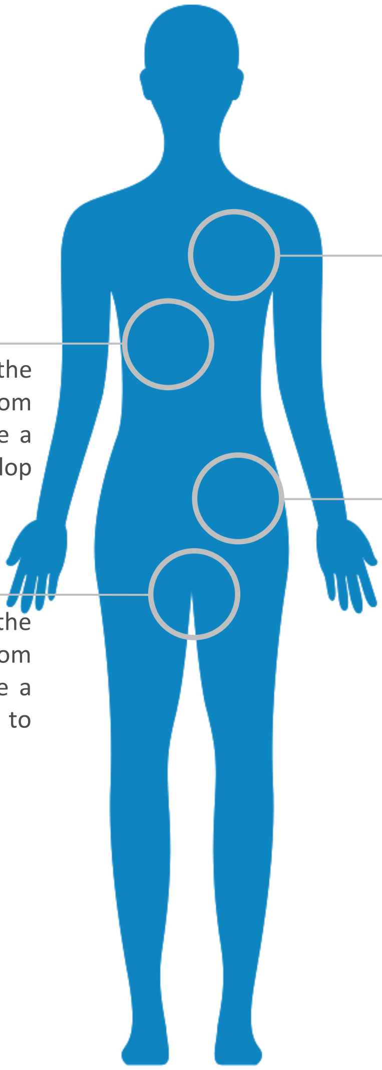
[6] NHS (2019): Fish and Shellfish, Eat Well, available at: https://www.nhs.uk/live-well/eat-well/fish-and-shellfish-nutrition

[7] Defra (2019): Family Food 2016/17: Purchases, available at: https://www.gov.uk/government/publications/family-food-201617/purchases

[8] Diabetes.co.uk (2019); Diabetes and obesity, available at https://www.diabetes.co.uk/diabetes-and-obesity.html

Type 2 diabetes: 4,000 to 4,900 cases could be avoided per year if increasing seafood consumption to two portions a week (with the risk of dying prematurely).



Type 2 diabetes

An individual increasing the weekly fish consumption from one to two portion will have a 15% reduced risk to develop Type 2 Diabetes

Colorectal cancer

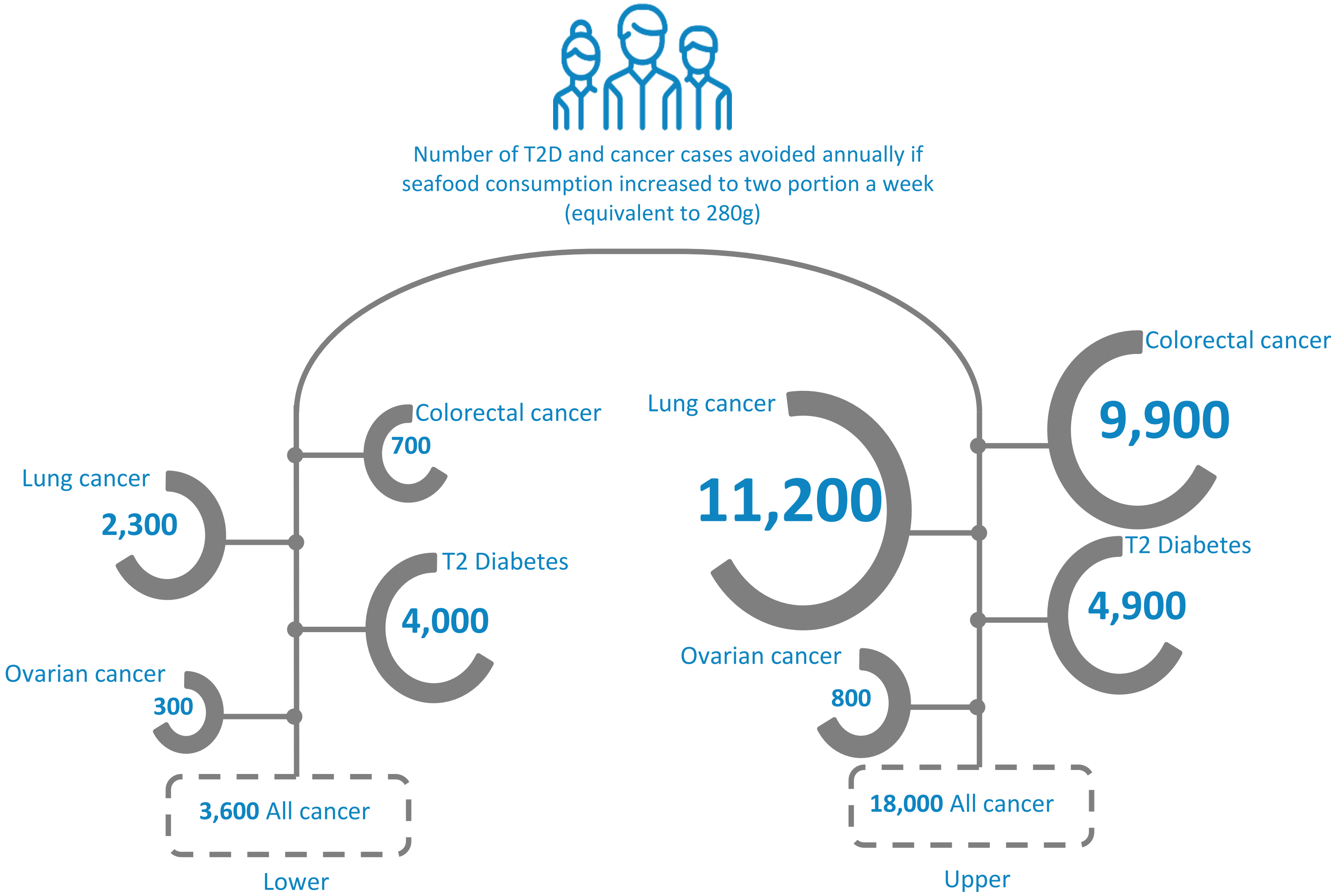
An individual increasing the weekly fish consumption from one to two portion will have a 30% - 42% reduced risk to develop colorectal cancer

Lung cancer

An individual increasing the weekly fish consumption from one to two portion will have a 40% reduced risk to develop lung cancer

Ovarian cancer

An individual increasing the weekly fish consumption from one to two portion will have a 42% - 44% reduced risk to develop ovarian cancer



'All cancer types' are included as a separate category and this includes different cancer codes (C00-C97). Modelling was possible for specific cancer types where evidence was more robust (lung, ovarian and colorectal). The modelling suggests that most cases avoided are expected for lung and colorectal cancer cases. Other modelling for other cancer types could not be undertaken due to scarcity of more robust data.

The number of cases avoided in England for T2D from increasing seafood consumption to two portions a week (280gr.) is estimated to range from 4,000 to 4,900 a year. Cancer cases will be reduced by 3,600 to 18,000 per year. The impacts will start in 2030, allowing a 10-year period for the effects to be noticeable and take into account the past trends in number of cases.

Table 1: Number of T2D and cancer cases avoided annually if seafood consumption increased to two portion a week (equivalent to 280gr.)

Type of cancer	Lower	Upper
Colorectal cancer	700	9,900
Lung cancer	2,300	11,200
Ovarian cancer	300	800
T2D	4,000	4,900
All cancers	3,600	18,000

Comparing the costs and benefits: summary of findings and recommendations

The economic benefits from the number of preventable cases as a result of increasing seafood consumption to two portions a week across the whole of England is estimated to exceed £24m/week or £1.3 bn per year under Approach 1, the most conservative approach. Under Approach 2, a higher estimate of £3.5bn per year, or £67m/week, are illustrative of the benefits of increasing seafood consumption. The benefits will accrue to both the NHS budgets and businesses from reduced absenteeism, because of reduced ill-health, but also to consumers in terms of reducing the risk of ill-health and better quality of life.

The costs to consumers across the whole of England will be expected to be of between £10 to £15m per week (across the whole of the population in England), or £1.65 per person per week on average.

The impacts from increasing seafood consumption in England

£270m-£600m savings to the NHS for preventable cases a year
- £196m-£241m savings to the NHS from preventable cases of T2D a year
- £72m-£360m savings to the NHS from preventable cancer cases a year

NHS will save £31,000 to £35,000 per patient over each patient's lifetime
- £70/week in benefits to patients from preventable cases of T2D linked to better quality of life
- £70/week in benefits to patients from preventable cancer cases linked to better quality of life

£1.65/week are the maximum weekly costs to consumers of buying more seafood across the whole of England, per person per week.

£160-£360m benefits to business from reduced absenteeism per year, linked to better health of workers eating 1 more portion of fish a week

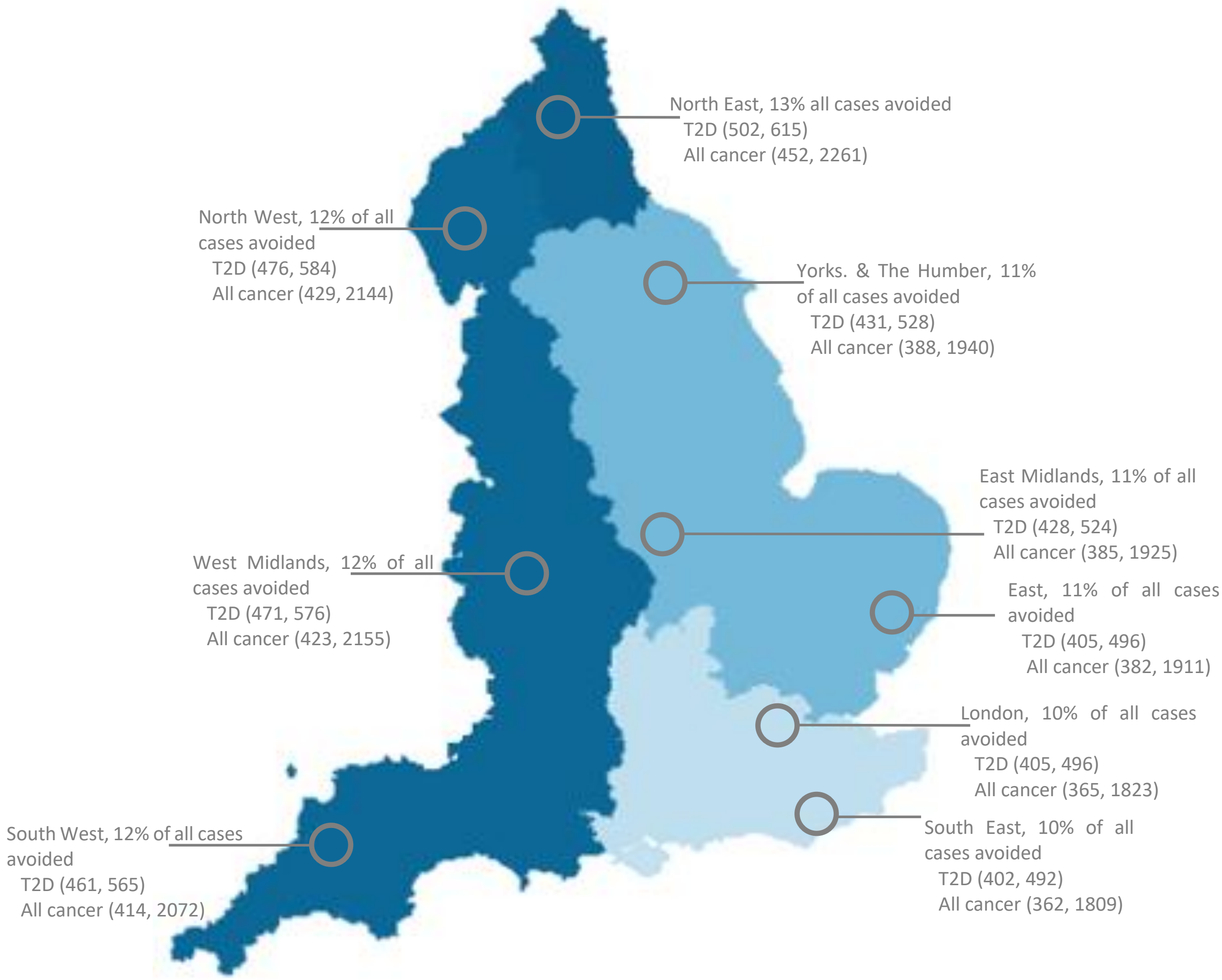
It is important to note that the benefits may not arise immediately and that they are only expected to accrue in the near future. This study assumes a 10-year timeframe for the benefits to arise[9].

Overall however, there will be net socio-economic gains, as the benefits from increased seafood consumption (in NHS budgets and business) will far exceed the costs to the consumers from buying what it can be a more expensive source of protein (although oil rich fish is considerably cheaper and affordable than other varieties).

As the current consumption levels are different by region and by age group however, the distribution of health outcomes, benefits and costs may be different across England. In particular:

- The average consumption of fish is higher in London and the South East and the smallest portions are on average consumed in the North East, North West and the West Midlands. The benefits from increasing consumption may be larger in these last few regions. The largest benefits will accrue in the North East where consumption is at its lowest;

Distribution of number of cases of T2D and cancer avoided by region in England per year

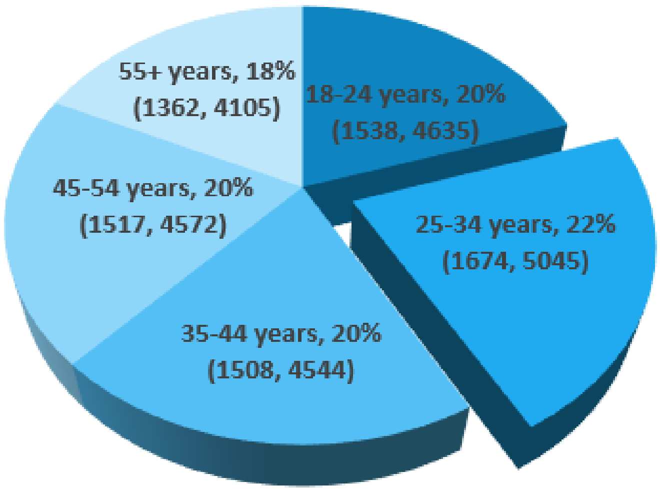


[9] It is thus expected that the benefits from eating one more portion of fish a week will accrue from 2030 onwards but the additional costs will accrue immediately. Over the lifetime of a person, the benefits are still expected to exceed the costs.

- younger groups are consuming less fish per week on average. Nearly half of the over 55 are already consuming 2 portions of fish a week. The following Figure shows the distribution of cases avoided by age group as % of total cases (T2D and all cancer) across all populations[10]. The cases avoided for each age group are given as a range in brackets. The figure shows:
  - ✓ 22% of all cases avoided (of T2D and all cancers) across all groups could fall on the 25-34 years age category. According to the model, this reduction would be equivalent to 1,674 to 5,045 cases avoided for that age group (preventable cases of T2D and all cancers; lower bound and upper bound respectively)
  - ✓ 18% of all cases avoided (of T2D and all cancers) across all groups could fall on the 55+ age category. This reduction would be equivalent to 1,362 to 4,105 of cases avoided for that age group (preventable cases of T2D and all cancers; lower bound and upper bound respectively).

As a result, the largest benefit will accrue to the 25 to 34 years group, currently consuming less fish than other age groups. This is important as such groups will be still within working age by 2030, when the benefits are expected to realise on a yearly basis.

T2D and all cancer cases avoided as a % of the total in England by age group (total by age group - lower and upper range - shown in brackets)



[10] Based on current consumption levels alone. The socio-economic model however takes account of the age at which the health impact may be diagnosed (refer to technical annex 1).

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Glossary

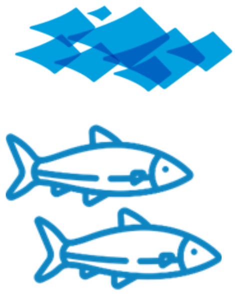
CBA	Cost-benefit analysis	An analysis comparing the benefits of an action as well as the associated costs, and subtracting the costs from benefits.
CEA	Cost-effectiveness analysis	Cost-effectiveness analysis (CEA) is a form of economic analysis that compares the relative costs and outcomes (effects) of different courses of action.
COI	Cost of illness studies	Cost of illness studies are a type of economic study common in the medical literature, particularly in specialist clinical journals. The aim of a cost of illness study is to identify and measure all the costs of a particular disease, including the direct, indirect, and intangible dimensions.
CMA	Cost-minimization analysis	Cost minimisation analysis is a method of comparing the costs of alternative interventions (including the costs of managing any consequences of the intervention), which are known, or assumed, to have an equivalent medical effect. This type of analysis can be used to determine which of the treatment alternatives provides the least expensive way of achieving a specific health outcome for a population.
CUA	Cost-utility analysis	Cost utility analysis (CUA) is an economic analysis in which the incremental cost of a program from a particular point of view is compared to the incremental health improvement expressed in the unit of quality adjusted life years (QALYs).
EPIC	European Prospective Investigation into Cancer and Nutrition	The European Prospective Investigation into Cancer and Nutrition (EPIC) is an ongoing multi-centre prospective cohort study designed to investigate the relationship between nutrition and cancer, with the potential for studying other diseases as well.
FCE	Finished Consultant Episodes (FCE)	This is the time a patient spends in the care of one consultant in one health-care provider (f a patient is transferred to a different hospital provider or a different consultant within the same hospital, a new episode begins).
HR	Hazard ratio	In survival analysis, the hazard ratio (HR) is the ratio of the hazard rates corresponding to the conditions described by two levels of an explanatory variable.
HRQoL	Health-related quality-of-life	Health-related quality of life (HRQoL) is a multi-dimensional concept that includes domains related to physical, mental, emotional, and social functioning. It goes beyond direct measures of population health, life expectancy, and causes of death, and focuses on the impact health status has on quality of life.
IR	Incidence rate	The incidence rate is a measure of frequency of occurrence of a disease or accident over a specified period of time. Incidence rate or “incidence” is numerically defined as the number of new cases of a disease, within a time period, as a proportion of the number of people at risk.
NICE	National Institute for Health and Care Excellence	The National Institute for Health and Care Excellence (NICE) provides national guidance and advice to improve health and social care; Producing evidence-based guidance and advice for health, public health and social care practitioners; Developing quality standards and performance metrics

		for those providing and commissioning health, public health and social care services; and Providing a range of information services for commissioners, practitioners and managers across health and social care.
NSHD	National Survey of Health and Development	The Medical Research Council (MRC) National Survey of Health and Development (NSHD) is the oldest of the British birth cohort studies. It is unique in having data from birth on the health and social circumstances of a representative sample (N=5362) of men and women born in England, Scotland or Wales in March 1946.
OVS	Oxford Vegetarian Study	The Oxford Vegetarian Study (OVS), also known as the Study of Cancer in Vegetarians, began in 1980; 11,040 participants were recruited through the Vegetarian Society of the United Kingdom, publicity in local and national media and by word of mouth between September 1980 and January 1984. Participants joined the study by voluntarily completing and returning a diet and lifestyle questionnaire. The aim of the study is to investigate the long-term health of vegetarians and comparable non-vegetarians, with particular interest in cancer risk and mortality.
PICOS criteria	Population, interventions, comparators, outcomes	The PICO process (or framework) is a mnemonic used in evidence-based practice (and specifically Evidence Based Medicine) to frame and answer a clinical or health care related question. The PICO framework is also used to develop literature search strategies, for instance in systematic reviews. The PICO acronym stands for • P – Patient, Problem or Population • I – Intervention • C – Comparison, control or comparator • O – Outcome(s) (e.g. pain, fatigue, nausea, infections, death)
PSSRU	Personal Social Services Research Unit	The PSSRU is a social care research groups stablished at the University of Kent at Canterbury in October 1974. It produces estimates of different healthcare costs for different health outcomes.
QALY	Quality-adjusted life year	The quality-adjusted life year (QALY) is a generic measure of disease burden, including both the quality and the quantity of life lived. It is used in economic evaluation to assess the value of medical interventions. One QALY equates to one year in perfect health. QALY scores range from 1 (perfect health) to 0 (dead). QALYs are also developed for different health condition.
RF	Risk factor	Risk factors are linked to poor health, disability, disease, or death. A risk factor is a characteristic, condition, or behaviour that increases the likelihood of getting a disease or injury.
UKWCS	UK Women's Cohort Study	The UK Women's Cohort Study is one of the largest cohort studies investigating associations between diet and cancer in the UK. A large cohort of over 35,000 middle aged women has been created encompassing a wide range of different eating patterns, including diets currently of interest to research into protection against cancer and coronary heart disease.
Utility		Utility measures of health-related quality of life are preference values that patients attach to their overall health status. In clinical trials, utility measures summarize both positive and negative effects of an intervention into one value between 0 (equal to death) and 1 (equal to perfect health).

1 Introduction

1.1 Background

In a healthcare system faced with financial stress, diseases related to lifestyle such as cardiovascular disease and diabetes have become an increasing concern not only for the NHS, but also for the economy overall. Diet is one of the modifiable factors that can influence susceptibility to such diseases.

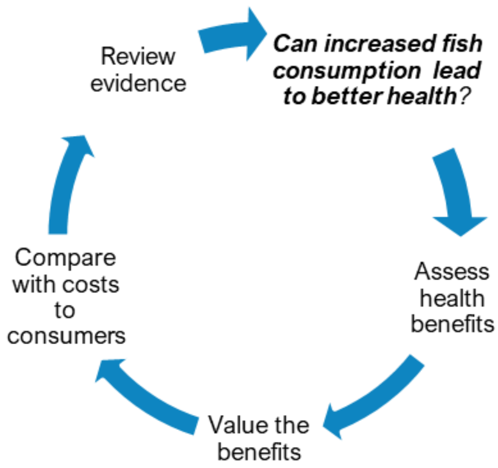


Studies over several decades have suggested a link between fish consumption and reductions in ill-health. NHS guidelines recommend that '*a healthy, balanced diet should include at least two portions of fish a week, including one of oil rich fish*'. However, household purchases of fish and fish products have fallen steadily since 2006. The current estimate for seafood consumption across England is half the recommended level.

This study is aimed at assessing the evidence on the socio-economic benefits that changes to the diet and increase seafood consumption can deliver. A review of the potential benefit of fish in the diet highlights that including fish in the diet produces several health benefits, particularly when compared to meat. These benefits stem mostly from weight control and reduced risk of being overweight, as fish is a lean source of protein with lower fat content.

The study has been commissioned to Risk & Policy Analysts (RPA) and Health Economics Consulting (HEC), at the University of East Anglia (UEA), by Seafood 2040 (SF2040). SF2040 is a programme facilitated by the Sea Fish Industry Authority (Seafish) and funded by the European Maritime Fisheries Fund (EMFF). It is also supported by the Department of Agriculture, Food and Rural Affairs (Defra) and England's seafood industry. SF2040 sets out a recommendation for reviewing the impacts of a population shift to two a week seafood consumption to better quantify the substantial socio-economic impacts of improved health (Recommendation 6). The study objectives are presented below.

1.2 Objectives



The purpose of this study is to review available evidence on the benefits from increasing seafood consumption and to understand the socio-economic impacts on population health and the potential, resulting savings of government spend on ill health. It will aim to show the health benefits and how these health benefits can be translated into net gains to the overall economy. This study will aim to substantiate the health benefits from a change in diet towards increased seafood consumption and assess the barriers and opportunities around seafood consumption growth. Such barriers can include additional costs to consumers.

1.3 Approach

The scope of the study included the socio-economic impacts derived from increased seafood consumption on health, i.e. better health, as well as the costs to the consumers from switching from meat to fish. Socio-economic effects include impacts on the government's budgets (e.g. NHS expenditure) and individuals, in terms of quality of life from a reduction in ill-health. Last but not least, there will be productivity gains to business from reduced absenteeism due to better health resulting from increased seafood consumption.

Scope inclusions

- ✓ NHS budgets
- ✓ Better quality of life from reduced ill-health
- ✓ Increased productivity at workplace

Scope exclusions

- ✗ Environmental impacts
- ✗ Impacts on the fishing industry
- ✗ Food poisoning (e.g. due to contaminants, heavy metals)

Excluded from the scope are environmental impacts, economic impacts to the fishing industry and health outcomes related to fish poisoning and contaminants.

The approach included both a review of the literature and economic modelling. The literature review included both academic sources as well as public authorities' publications.

The preference in study selection for the literature review was for UK based studies. The systematic review of the literature evaluated the main sources of evidence; consequently, only the health outcomes where the evidence was the most robust were included in the model. The model produced two estimates, a more conservative and a less conservative estimate (reflecting the different shift in diets).

Valuation follows existing government guidance (National Institute for Care and Health Excellence (NICE) guidance) and included both market-based and quality of life type measures. The current incidence rate of the different illness, mortality rates and consumption levels were also used to value the impacts.

1.4 Structure of this report

The rest of the report is structured as follows:

- Section 2 describes the baseline in terms of current consumption by age and region: in order to assist with the distribution of impacts and to assess the costs of increasing consumption of fish to consumers.
- Section 3 presents the findings of the model on the different health outcomes and the literature is also presented.
- Section 4 describes and present the monetary values association with the different impacts, health and non-health derived.
- Section 5 summarises the findings and the main issues with the interpretation of data.
- More details on the approach and methods are given in Annex 1.

2 Current seafood consumption in England

2.1 Introduction

This Section looks at current consumption levels to establish the baseline from which health benefits from increased consumption can be measured and the costs to consumers from changes in diet can be estimated.

The Section also describes the different consumption levels by group, age group, income bracket and location. This is because benefits may differ according to age group (e.g. working age versus people in non-working age). Location is relevant as health impacts may concentrate in specific areas where fish consumption levels are at its lowest. The scope of the study included an analysis of impacts for different regions and groups as this may help with setting priorities for action. When current consumption is at its lowest, benefits are expected to be larger comparatively.

2.2 Data for baseline setting

To establish the baseline scenario for seafood consumption, a main source of data for the research is the Family Food Survey (Defra, 2019[11]). The Family Food Survey is an annual publication containing statistical information on purchased quantities, expenditure and nutrient intakes derived from both household food and drink and eating out. For the purpose of this study, data have been taken from the 2016/2017 edition of the survey, the latest available at the time the modelling was conducted.

In addition, information has been provided by Seafish on recent consumption from their own commissioned work. This information includes the following:

- Results of a survey conducted by YouGov for Seafish in 2018 which examined fish consumption by different age groups and regions in the whole of the UK including England;
- Results of a pulse survey commissioned by Seafish for the Seafood Week 2019 campaign. This examined attitudes towards increased fish consumption through surveying 2,500 respondents in the UK excluding those aged between 35 and 44. Although the Pulse survey included the UK population, findings are expected to be transferable to the English population.

2.3 Baseline consumption levels

This section provides a description of current consumption levels of fish, divided by age and geographical region.

Consumption levels by age

The results of the 2018 Seafish survey on YouGov showed that the older consumer group is closer to the recommended intake of two portions a week (equivalent to 280 g) than younger consumer groups.

The following figure summarises the findings on fish consumption by age group. Taking into account the sample sizes, it is important to note that within the older population, a greater number of over 55s will consume fish twice or more a week whereas people in the other age groups are more likely to have fish only once a week. Of the total population sampled, 9% do not eat fish; some of these

[11] Defra (2019): **Family food statistics,** available at: https://www.gov.uk/government/collections/family-food-statistics

being vegetarians or vegans (42% of the 9% equivalent to 4% of the total English population). By age, the latter group will mostly be younger groups.

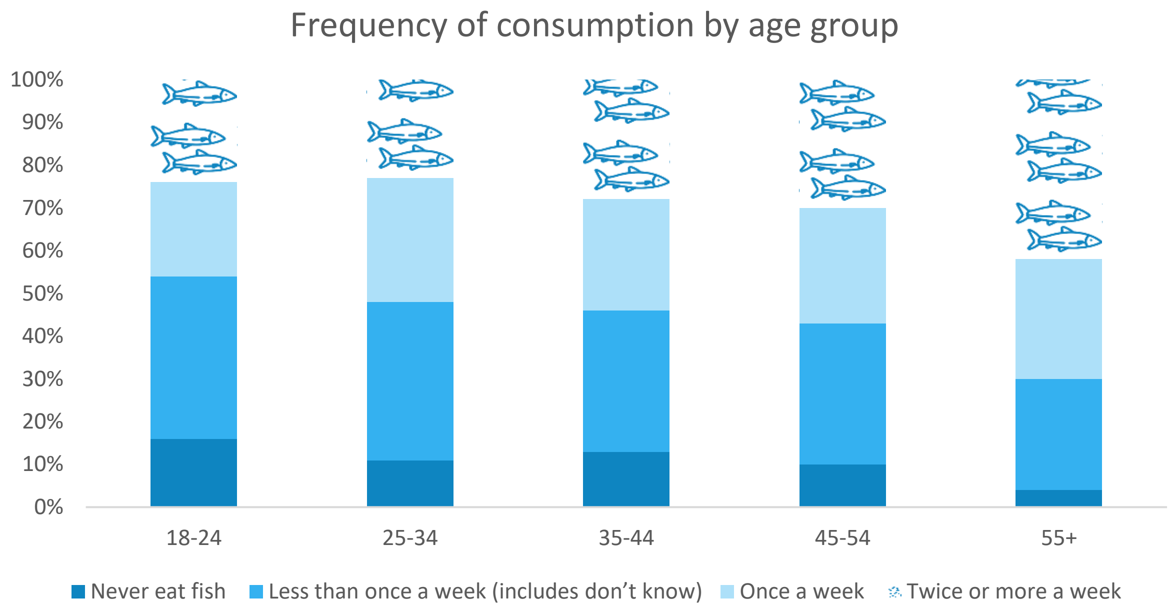
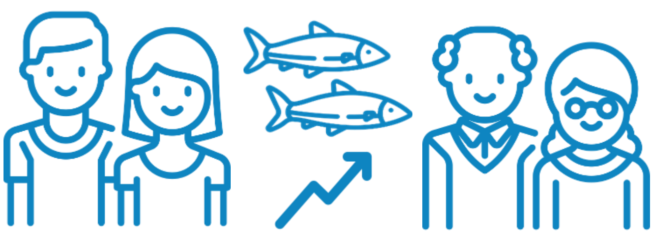


Table 2-1: Frequency of fish consumption by age group (2018) – England					
Frequency/Age group	18-24 % of n	25-34 % of n	35-44 % of n	45-54 % of n	55+ % of n
All adults (N=1719)	11%	15%	18%	16%	40%
Twice or more a week	24%	23%	28%	30%	42%
Once a week	22%	29%	26%	27%	28%
Less than once a week (includes don't know)	38%	37%	33%	33%	26%
Never eat fish	16%	11%	13%	10%	4%

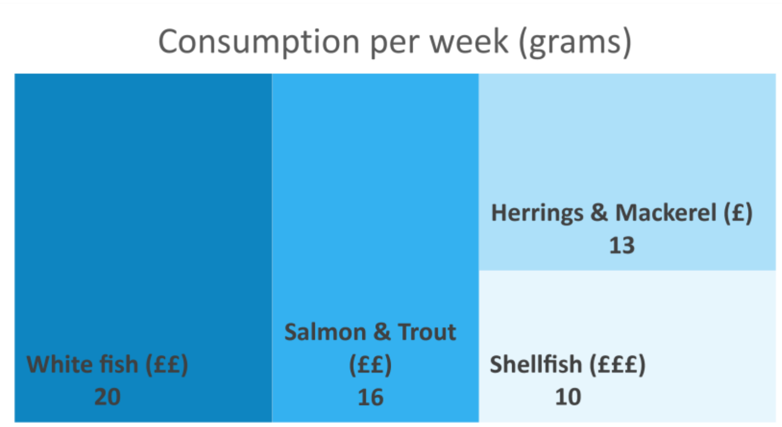


The Pulse survey commissioned by Seafish (2019[12]) concluded however that 65% of those interviewed would like to eat more fish or shellfish. Among the different demographics, those over 55 would appear to be keener to increase consumption; but the younger groups also show a positive intention, with 67% of the 25 to 34 years old wishing to increase seafood consumption. Currently, this group is more likely to eat fish only

12 Seafish (2019): One Pulse Evaluation for the Seafood Week, the total population was 2,500 respondents in the UK but excluded those aged between 35-44.

once a week or less (refer to Table 2-2).

Table 2-2: Would you like to eat more fish (N=2509) – UK population		
	Yes	No
18-20	55%	45%
21-24	64%	36%
25-34	67%	33%
55-64	72%	28%
Source: Seafish (2019)		



The Pulse survey reported that among the main reasons given for not eating more fish were that fish is expensive[13]. When asked about the type of fish bought in the last purchase, most respondents answered the most expensive varieties, i.e. salmon, prawns, cod and tuna above other cheaper types, such as mackerel or mussels.

Table 2-3 sets out the current expenditure by type of fish across England as well as the average price per kilogram paid. As seen from Table 2-3, fish species like herring and mackerel are significantly cheaper than other types (last column).

Table 2-3: Expenditure per week in England in different types of fish – average 2015/2017			
Type of fish	Consumption per week (in g)	Weekly expenditure per person (£)	Average price per kg
White fish	20	0.26	12.94
Herrings, Mackerel	13	0.07	5.67
Salmon & trout	16	0.24	14.78
Shellfish	10	0.16	16.42
Source: Seafood Industry Factsheet (2018)			

The benefits to people not currently eating fish because of choice, i.e. being vegetarian, have not been included in the total estimates as these groups may not change their diet for personal reasons. Our main assumption is that consumers who have decided not to eat seafood for personal reasons will not change their diet. As a result, baseline data on the % of population currently being vegan or vegetarian (9% of the total population) has been used to exclude this group from the calculation of total socio-economic impacts across England (for both the costs and benefits of increasing sea food consumption). Hence, the socio-economic impacts from increasing the seafood consumption have not been assessed for this dietary group.

[13] Total responses for this question being 1,626

Consumption levels by geographic location

The following Figure and Table 2-2 summarises the findings on the frequency of fish consumption by geographical region. As the table predicts, more than half of the adult population in England eat seafood either once or twice or more per week. The proportion of the consumers, never eating fish is relatively low, and its lowest occurs in the North. From those eating seafood twice or more per week, the largest proportion is in London (39% of consumers living in London), followed by the North and East (in both regions, 33% of the consumers eat seafood twice or more). From those consumers who consume seafood once a week, the majority can be found in the East (28%). Therefore, we expect the socio-economic impacts to be larger in this region. In this case, the number of new cases of diseases avoided, will be slightly concentrated within this region, and as a result the benefits, in terms of NHS, Government, and patient savings will be higher in this region.

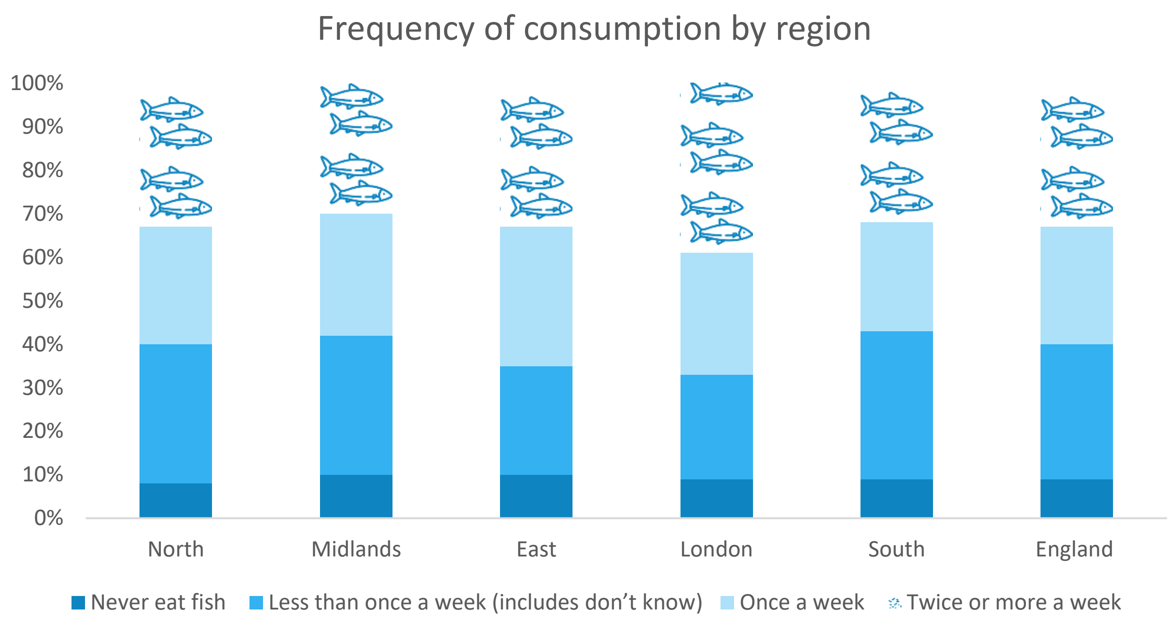


Table 2-4: Frequency of fish consumption by geographical region (2018) - England						
Frequency / geographical region	North	Midlands	East	London	South	England
Twice or more a week	33%	30%	33%	39%	32%	33%
Once a week	27%	28%	32%	28%	25%	27%
Less than once a week (includes don't know)	32%	32%	25%	24%	34%	31%
Never eat fish	8%	10%	10%	9%	9%	9%
Source: YouGov survey (2018) (N=1719)						

Table 2-5 sets out the different consumption of fish per person per week across the different regions, in grams. As it can be seen from the table, the average consumption across England is 144 g, which is equivalent to one portion[14]. There is however significant variation across the different regions, with

[14] A portion is around 140g (4.9oz).

the North East of England consuming 13% less than the national average and with London and the South East consuming 7-8% above the national average.

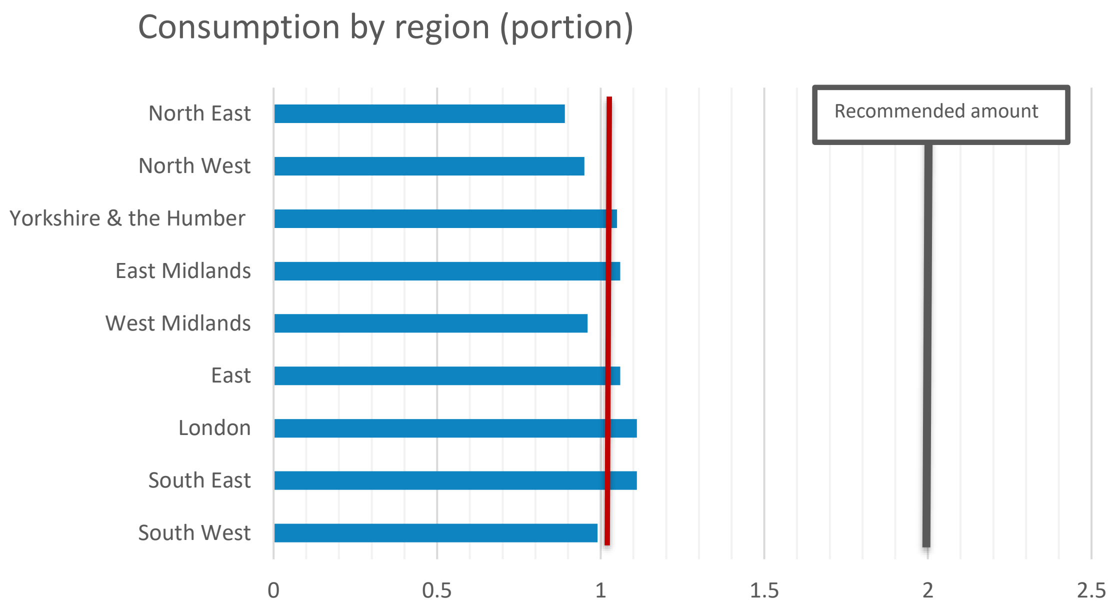


Table 2-5: Average consumption of fish per person per week (grams and portion size) – England and regional average, 2015 to 2017										
Fish	North East	North West	Yorkshire & The Humber	East Midlands	West Midlands	East	London	South East	South West	England
	125	133	147	148	135	149	155	156	138	144
Portion size per week	**0.89**	**0.95**	**1.05**	**1.06**	**0.96**	**1.06**	**1.11**	**1.11**	**0.99**	**1.03**
Source: GOV.UK (nd): National Diet and Nutrition Survey. Available at https://www.gov.uk/government/collections/national-diet-and-nutrition-survey *on 3rd October 2019*										

Moreover, when looking at the type of fish, it needs to be observed that takeaways are the largest type consumers eat across England, as this pattern is repeated across all regions, as depicted in Table 2-6.

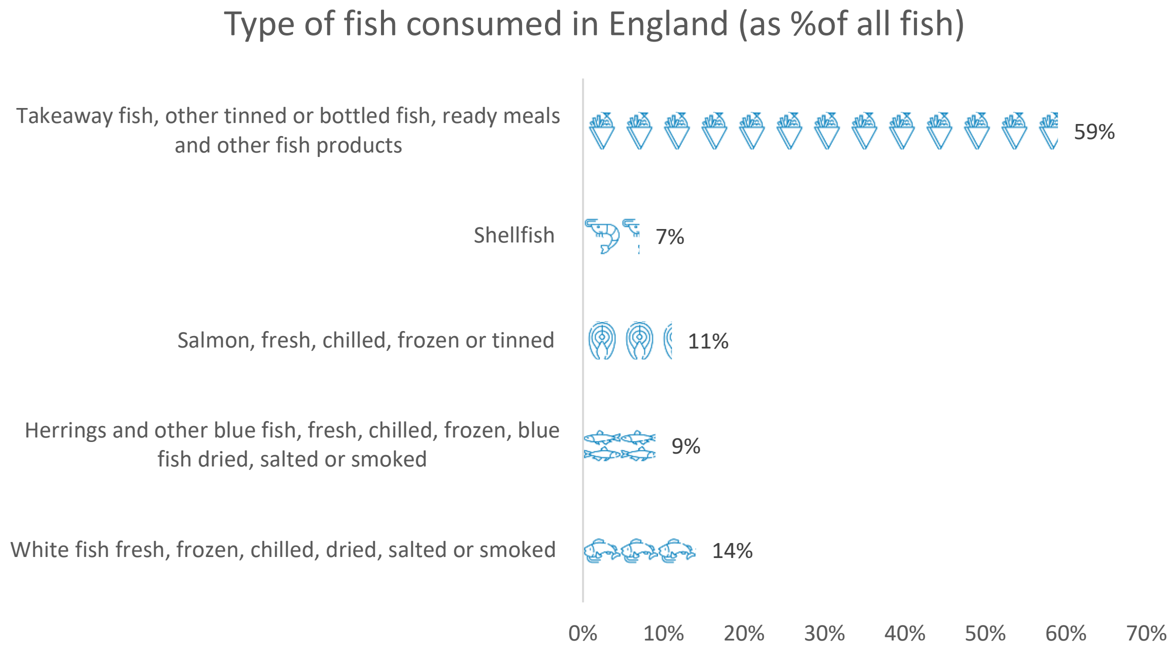


Table 2-6: Average consumption of fish per person per week (as % of total seafood consumption) – England and regional average, 2015 to 2017

Fish	North East	North West	Yorkshire & The Humber	East Midlands	West Midlands	East	London	South East	South West	England
	125	133	147	148	135	149	155	156	138	144
White fish fresh, frozen, chilled, dried, salted or smoked	10%	14%	12%	13%	11%	13%	23%	13%	12%	14%
Herrings and other blue fish, fresh, chilled or frozen, blue fish dried, salted or smoked	7%	6%	5%	7%	7%	9%	9%	12%	9%	9%
Salmon, fresh, chilled, frozen or tinned	8%	11%	11%	11%	11%	11%	14%	11%	12%	11%
Shellfish	6%	7%	7%	7%	6%	6%	7%	8%	7%	7%
Takeaway fish, other tinned or bottled fish, ready meals and other fish products	69%	62%	65%	62%	65%	61%	47%	56%	60%	59%
White fish includes cod, plaice, haddock. Blue fish includes herrings, kippers, mackerel, sprats, sardines, trout, tuna										
Source: GOV.UK (nd): National Diet and Nutrition Survey. Available at *https://www.gov.uk/government/collections/national-diet-and-nutrition-survey* *on 3rd October 2019*										

2.4 Discussion

The baseline consumption levels detailed above have presented the current consumption levels across the UK, by age group and geographical location, and the type of fish that are currently consumed in largest quantities.

Current data suggest that across England, the average consumption is only one portion a week but other important findings need to be carried forward to assess the impacts from increasing consumption to two portions a week in order to assess how the distributional effects of the impacts across age groups and regions. In particular:

In England, 44% of the population over 55s already consume two portions of fish a week (280 g of fish). Over half of the English population under 55s, and especially the youngest, consume one or less portion of fish a week but most wish to increase consumption.

Average fish consumption per week in England is around 140 g (a portion) with the lowest consumption in the North East (13% below the national average).

However, all the age groups would like to increase their fish consumption; the main reason argued against being the costs. Moreover:

59% of all fish consumer are takeaway fish, other tinned or bottled fish or ready meals, which is not the one with the most nutritional value and the cheapest variety.

Herring and mackerel have high nutritional value and are inexpensive varieties and current consumption could increase.

3 Health outcomes from increased seafood consumption

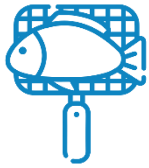
3.1 Introduction

Fish is known for its low-fat content. White fish typically contains only 1 to 2 % fat. Moreover, although the enduringly popular takeaway choice of fish and chips can have 1,650 calories (kcal), because of the chips, frying process and portion size, smaller portions can reduce the calorie intake significantly, down to 950 calories. A small portion of fried fish alone is no more than 350 calories[15]. Healthier cooking choices include baking, steaming and poaching, thus limiting the loss of nutrients.

Fish and Chips, small portion
950kCal

Steamed Salmon, 100g steak
194kCal

Sardines, 50g drained portion
110kCal



Grilled Halibut, 145g steak
175kCal

Fish is also good source of protein, containing on average 19 g of protein per 100 g and is recommended as part of a healthy diet to treat obesity[16]. The Health Survey for England 2017 estimates that 28.7% of adults in England are obese and a further 35.6% are overweight. Obesity can lead to a number of serious and potentially life-threatening conditions. These include:

- Type 2 diabetes (T2D);
- Coronary heart disease;
- Some types of cancer, such as breast cancer and bowel cancer; and
- Stroke.

Obesity can also affect quality of life and lead to psychological problems, such as depression and low self-esteem.

Oil rich fish is also a good source of Vitamin D. Deficiency in vitamin D has been associated with potential long-term health problems, including the risk of cardiovascular disease, autoimmune disease and cancer. The UK has a high proportion of vitamin D deficiency in young adults, older adults and certain ethnic minorities[17].

This section presents the available and most robust evidence on the health outcomes related to dietary habits and fish consumption. It then values the impacts in economic terms from reduced ill-health. The approach to modelling is given in Annex 1[18]. Finally, it provides information about how

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[15] https://www.nutracheck.co.uk/calories/calories_in_takeaways/calories_in_chip_shop_fish__chips

[16] See Annex 1 - Table A1-1, for more information on the nutritional value of fish.

[17] The typical UK diet provides around 3 µg of vitamin D per day which is much lower than the recommended daily vitamin D intake (10 µg of vitamin D per day). The majority of this comes from fortified foods (e.g. fat spreads and breakfast cereals). Source: NHS (2017): Vitamins and minerals- Vitamin D. Available at: https://www.nhs.uk/conditions/vitamins-and-minerals/vitamin-d/ on 26th September 2019

[18] In our model, Hazard Ratios (HR) have been used to estimate the reduction in incidence of specific health outcomes related to increased fish consumption. More information is provided in the Annex.

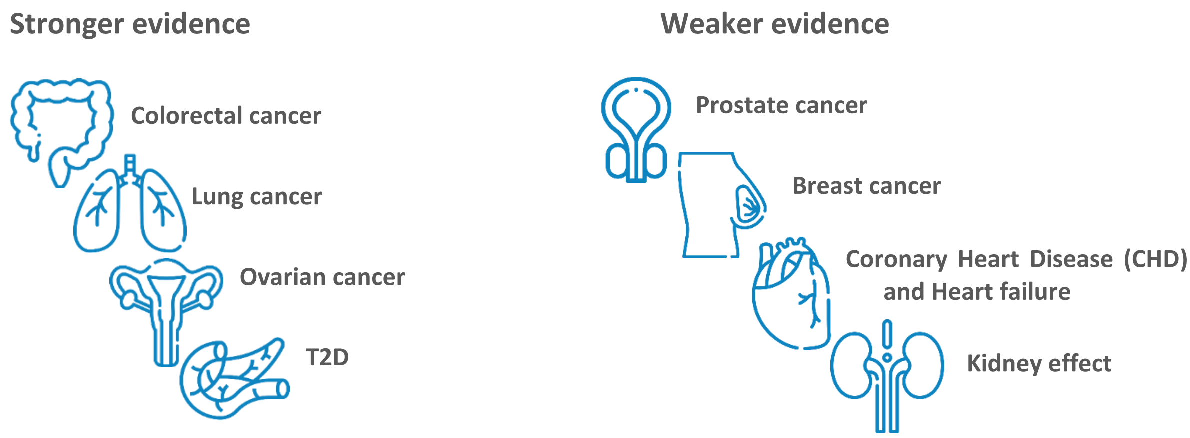
the number of cases avoided may be geographically distributed and different by age group, based on current consumption levels (as described in the earlier section).

3.2 Main health outcomes from increased fish consumption

The next sections show by order of relevance the main health outcomes found in the literature as associated with fish consumption. It is important to note that only the most relevant evidence is reviewed and presented below. Some studies were not considered robust enough for inclusion in this research due to small sample sizes or results of little statistical significance.

3.2.1 Morbidity impacts

The literature review has revealed morbidity impact studies of varying quality. The figure below sets out the health outcomes where the evidence has been found to be the most robust, based on the quality of the studies and transferability of results. A more detailed table on the different health outcomes and evidence review is provided in Annex 1.



Health outcomes and assessment of evidence- Findings

Some of the studies found reviewed more than one health outcome, i.e. Appleby, Key and Segovia, and are presented below. The context of the study is presented once for brevity. It is important to note that the reduced risk of developing a health condition from increasing seafood consumption is assessed by replacing other main food categories[19] in one to one portion (as opposed to increasing food consumption in total). Annex 1 provides more information about the relative risks used in the modelling.

Colorectal cancer

The latest data for 2013 shows over 34,000 cases of colorectal cancer diagnosed in England with predictions going up to over 50,000 cases in the next 20 years.

[19] The epidemiological studies have defined four dietary groups, regular meat eaters, low meat eaters, fish eaters and vegetarians. The consumption levels of different food categories vary across the studies, but the in principle, the following dietary patterns arise:

- Regular meat eaters: eating red processed meat, five or more times per week, and fish once or twice a week;
- Low meat eaters: eating red meat twice a week and fish twice a week;
- Fish eaters: eating no meat at all, but eating fish twice a week;
- Vegetarians: eating no meat, or fish at all.

Dietary factors have a significant impact on the risk of cancer, with different dietary elements either increasing or reducing the risk of cancer. These effects are also associated with other factors, including alcohol consumption, smoking status, physical exercise, and obesity. Some foods can affect the risk of bowel cancer. It is estimated that around 13 out of 100 bowel cancer cases (around 13%) in the UK are linked to eating red and processed meats (Cancer Research UK, 2018)[20]. There is enough robust evidence on the link between increased fish consumption and a reduction of risk to develop colorectal cancer.

An individual increasing the weekly fish consumption from one to two portions will have a 30%-42% lower probability to develop colorectal cancer than a non-fish eater (although this reduction is expected to be smaller for women).

Four studies with UK populations have been identified to be of relevance on the link between dietary intakes and the risk of developing colorectal cancer. The main findings are rather conclusive regarding the benefits of eating fish and reducing the risk of developing colorectal cancer as follows:

Appleby et al (2016)[21] compared the mortality in vegetarians and nonvegetarians in the UK (over a sample of 60,000 individuals over a time up to 15 years). Different dietary groups were included[22]. When comparing the results among the groups, low meat eaters were found to have a 4% lower probability of developing colorectal cancer relative to regular meat eaters. The probability of developing colorectal cancer for fish eaters compared to regular meat eaters was found to be 39% lower. Fish eaters were also compared with non-fish eaters (vegetarians and vegans) and found to be at a 42% reduced risk of being diagnosed with colorectal cancer.

The study conducted by Key et al. (2014)[23] is focused on 20 common cancer types in the British population. The study identifies four dietary groups: meat eaters, fish eaters, vegetarians, and vegans. Results showed that fish eaters have a 33% lower probability to develop colorectal cancer, relative to meat eaters and vegetarians. When fish eaters are compared with vegans, the risk for fish eaters is smaller by 35%.

A more recent study by Segovia-Siapco[24] (2018) included more dietary groups than any of the above studies[25]. The study findings suggest a positive link between fish intake and a reduction in risk of colorectal cancer for particular groups, with a fish eater having a 33% lower probability of developing colorectal cancer, compared to a low meat eater.

[20] Cancer Research UK (2018), available at: https://www.cancerresearchuk.org/about-cancer/bowel-cancer/risks-causes

[21] Appleby, Paul N., Francesca L. Crowe, Kathryn E. Bradbury, Ruth C. Travis, and Timothy J. Key. 2016. "Mortality in Vegetarians and Comparable Nonvegetarians in the United Kingdom." American Journal of Clinical Nutrition 103 (1): 218–30. https://doi.org/10.3945/ajcn.115.119461.

[22] On average, regular meat eaters eat 43 g of fish per day, (14 g of which is oil rich fish), low meat eaters eat 40 g of fish per day (16 g of which is oil rich fish), fish eaters eat 40 g of fish per day (16 g of which is oil rich fish), vegetarians and vegans do not eat fish at all.

[23] Key, Timothy J., Paul N. Appleby, Francesca L. Crowe, Kathryn E. Bradbury, Julie A. Schmidt, and Ruth C. Travis. 2014. "Cancer in British Vegetarians: Updated Analyses of 4998 Incident Cancers in a Cohort of 32,491 Meat Eaters, 8612 Fish Eaters, 18,298 Vegetarians, and 2246 Vegans." American Journal of Clinical Nutrition 100 (SUPPL. 1): 378–85. https://doi.org/10.3945/ajcn.113.071266.

[24] Segovia-Siapco, Gina, and Joan Sabaté. 2018. "Health and Sustainability Outcomes of Vegetarian Dietary Patterns: A Revisit of the EPIC-Oxford and the Adventist Health Study-2 Cohorts." European Journal of Clinical Nutrition, no. April. https://doi.org/10.1038/s41430-018-0310-z.

[25] The EPIC – Oxford and the Adventist Health Study-2 cohorts

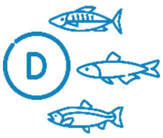
Rada-Fernandez de Jauregui (2018)[26] examined a sample of more than 32,000 women in the UK with different diets. The study findings showed a 10% smaller risk for fish eaters than red meat eaters of developing colorectal cancer.

Supporting the above, there is also a study on Polish population with comparable reductions. (Jedrychowski et al, 2008)[27]. Although its estimates have not been used in the modelling, the support the findings and the use of the values from the studies above.

Lung cancer

There were around 38,000 cases of lung cancer in England per year from 2014 to 2016[28]. With an increase in the incidence by 2% each year, the forecast for 2040 gives an estimate of 55,700 cases.

A balanced diet can help to reduce the risk of developing cancer but can also help to manage a lung condition and ease the symptoms (British Lung Foundation, 2019)[29]. A diet high in vitamin D may have benefits for people with lung cancer as well. Vitamin D is found in fatty fish such as salmon, mackerel, and herring.



There are two robust studies identified during the literature review examining the risk of developing lung cancer and the consumption of fish, showing that:

An individual increasing the weekly fish consumption from one to two portions will have a 40% lower probability to develop lung cancer

Appleby et al. (2016) estimated the risk of developing lung cancer among regular meat eaters, low meat eaters, fish eaters, vegetarians and vegans. On average, fish eaters have a 43% lower probability to develop lung cancer compared to regular meat eaters, vegetarians and vegans.

Key et al. (2014) calculated the risk to be diagnosed with lung cancer for different diet groups. Fish eaters developed a reduced risk of lung cancer compared to meat eaters and vegetarians and vegans (a 41% smaller probability relative to a regular meat eater and 45% smaller than vegetarian and vegans).

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[26] Rada-Fernandez de Jauregui, Diego, Charlotte E.L. Evans, Petra Jones, Darren C. Greenwood, Neil Hancock, and Janet E. Cade. 2018. "Common Dietary Patterns and Risk of Cancers of the Colon and Rectum: Analysis from the United Kingdom Women's Cohort Study (UKWCS)." International Journal of Cancer 143 (4): 773–81. https://doi.org/10.1002/ijc.31362.

[26] Polish population in a hospital-based study from 2000 to 2008. The evidence from this study suggests that increased fish intake may have a preventative effect on colorectal cancer. When comparing individuals who eat less than one serving per week, those who eat 1-2 servings of fish per week had a reduction in risk by 30% of developing colorectal cancer. The results of this study are statistically significant and moreover, show the effect of an increase in fish consumption similar to the intervention assessed here (i.e. one portion a week increase). Jedrychowski, Wieslaw, Umberto Maugeri, Agnieszka Pac, Elzbieta Sochacka-Tatara, and Aleksander Galas. 2009. "Protective Effect of Fish Consumption on Colorectal Cancer Risk: Hospital-Based Case-Control Study in Eastern Europe." Annals of Nutrition and Metabolism 53 (3–4): 295–302. https://doi.org/10.1159/000195770.

[28] /health-professional/cancer-statistics/statistics-by-cancer-type/lung-cancer/incidence#heading-Zero

[29] https://www.blf.org.uk/support-for-you/eating-well/diet-and-my-symptoms

Ovarian cancer

There are about 7,000 new cases of ovarian cancer each year in the UK and approximately 5,000 are in England.

Being overweight is known to increase the risk of ovarian cancer. A healthy diet is recommended to minimise the risk. **An individual increasing the weekly fish consumption from one to two portions will have a 30%-44% lower probability to develop ovarian cancer.**

Two of the above-mentioned studies have shown a link between fish consumption and the risk of developing ovarian cancer.

Appleby et al. (2016) concluded that fish eaters have a 42% lower probability to develop ovarian cancer than regular meat eaters. When fish eaters are compared with vegetarians and vegans, the risk reduction for fish eaters is estimated to be 30%.

Key et al. (2014)'s study concluded that fish eaters have a 44% smaller risk of developing ovarian cancer than meat eaters and a 35% smaller risk than vegetarians and vegans.

Type 2 diabetes

There are currently 3.4 million people with T2D in England with around 200,000 new diagnoses every year. Projections suggest that more than 5 million people will suffer from Type 2 diabetes by 2025 (NHS, 2019).

T2D is largely preventable through lifestyle changes. There is strong international evidence which demonstrates how behavioural interventions, which support people to maintain a healthy weight and be more active, can significantly reduce the risk of developing the condition (NHS, ibid).

An individual increasing the weekly fish consumption from one to two portions will have a 15% to 53% smaller risk to develop Type 2 Diabetes.

Two studies have been found a relationship between diabetes and increased fish consumption:

- *Patel et al. (2012) reported statistically significant results for lower risk of developing diabetes with varying levels of oil rich fish consumption in European populations and provides suitable estimates for the economic modelling[30]. The results of the study show that people consuming two portions of fish per week have 4% lower risk to develop T2D, compared to those who consume one portion of fish. The study has different estimates for specific types of fish. Increasing the consumption of oil rich fish from one to two portions per week leads to a 15% lower risk to be diagnosed with diabetes.*
- *A recent study by Papier et al. (2019)[31] with over 45,000 participants (approximately 17.6 years of follow-up) found that compared with regular meat eaters, the low meat eaters, fish eaters and vegetarians were less likely to develop diabetes. Fish eaters consuming two*

[30] Patel PS, Forouhi NG, Kuijsten A, Schulze MB, van Woudenbergh GJ, Ardanaz E, et al., (2012). The prospective association between total and type of fish intake and type 2 diabetes in 8 European countries: EPIC-InterAct Study. Am J Clin Nutr., 95(6), pp.1445-53.

[31] Papier, Keren, Paul N. Appleby, Georgina K. Fensom, Anika Knuppel, Aurora Perez-Cornago, Julie A.Schmidt,Tammy Y.N. Tong, and Timothy J. Key. 2019. "Vegetarian Diets and Risk of Hospitalisation or Death with Diabetes in British Adults: Results from the EPIC-Oxford Study." Nutrition and Diabetes 9 (1). https://doi.org/10.1038/s41387-019-0074-0.

portions per week had a 53% lower risk to be diagnosed with diabetes, compared with regular meat eaters. The meat eat group however consume the same amount of fish, and the only difference is the consumption of meat.

3.2.2 Mortality impacts

In addition to morbidity, it is also important to capture the losses resulting from premature death from the above illnesses as they will be different socio-economic implications. The losses from mortality impacts are greater than those of morbidity because there of the direct medical costs, loss of lifetime earnings and human loss. Annex 1 provides more details on the method used to incorporate changes in lifetime expectancy and mortality rates from the health outcomes given above.

3.3 Health outcomes from increased seafood consumption

It is important to note that the benefits, in terms of the reduced cases and therefore savings for the governments, businesses and patients, may not arise immediately and that they are only expected to accrue in the near future. This study assumes a 10-year timeframe for the benefits to arise. It is thus expected that the benefits from eating one more portion of fish a week will accrue from 2030 onwards over the lifetime of patients.

All cancers: 3,600 to 18,000 could be avoided per year if increasing seafood consumption to two portions a week

Type 2 diabetes: 4,000 to 4,900 cases could be avoided per year if increasing seafood consumption to two portions a week

The following table summarises the number of cases avoided based on the epidemiological evidence and the current incidence rates over the lifetime of patients with increases in seafood consumption to two portions a week. For each health outcome, two different estimates on the number of cases avoided are provided to reflect the uncertainty and variation reflected in the study. More information is provided in Annex 1.

Table 3-1: Number of cases avoided

Type of fish	Lower range	Upper range
Colorectal cancer	700 Low range compares regular with low meat eaters	9,900 Upper range compares fish eaters with vegetarians
Lung cancer	2,300 Low range compares regular with low meat eaters	11,200 Upper range compares fish eaters with vegetarians
Ovarian cancer	300 Low range compares regular with low meat eaters	800 Upper range compares fish eaters with vegetarians
T2D	4,000 Low range compares fish eaters with vegetarians	4,900 Upper range compares regular with low meat eaters
All cancers	3,600 Low range compares regular with low meat eaters	18,000 Upper range compares fish eaters with vegetarians

Distribution by geographical location

As it was shown in section 2, the current consumption levels across the different English regions vary, with the average consumption of fish being higher in London and the South East (although not yet close to the recommendation of two portions a week). Against this, the smallest portions are on average consumed in the North East, North West and the West Midlands.

Different baseline consumption levels would entail that the benefits from increasing consumption may be larger in some regions than others. Different adjustment factors have been applied based on this. The largest benefits will accrue in the North East where consumption is at its lowest.

The following tables, Tables 3-2 and 3-3, show the distribution of health outcomes per region in a greater level of detail by individual health outcome, also based on the current consumption level and thus assuming a greater increase in those regions where the current consumption of fish is smaller. They provide a lower and upper range of our estimates, to reflect the uncertainty.

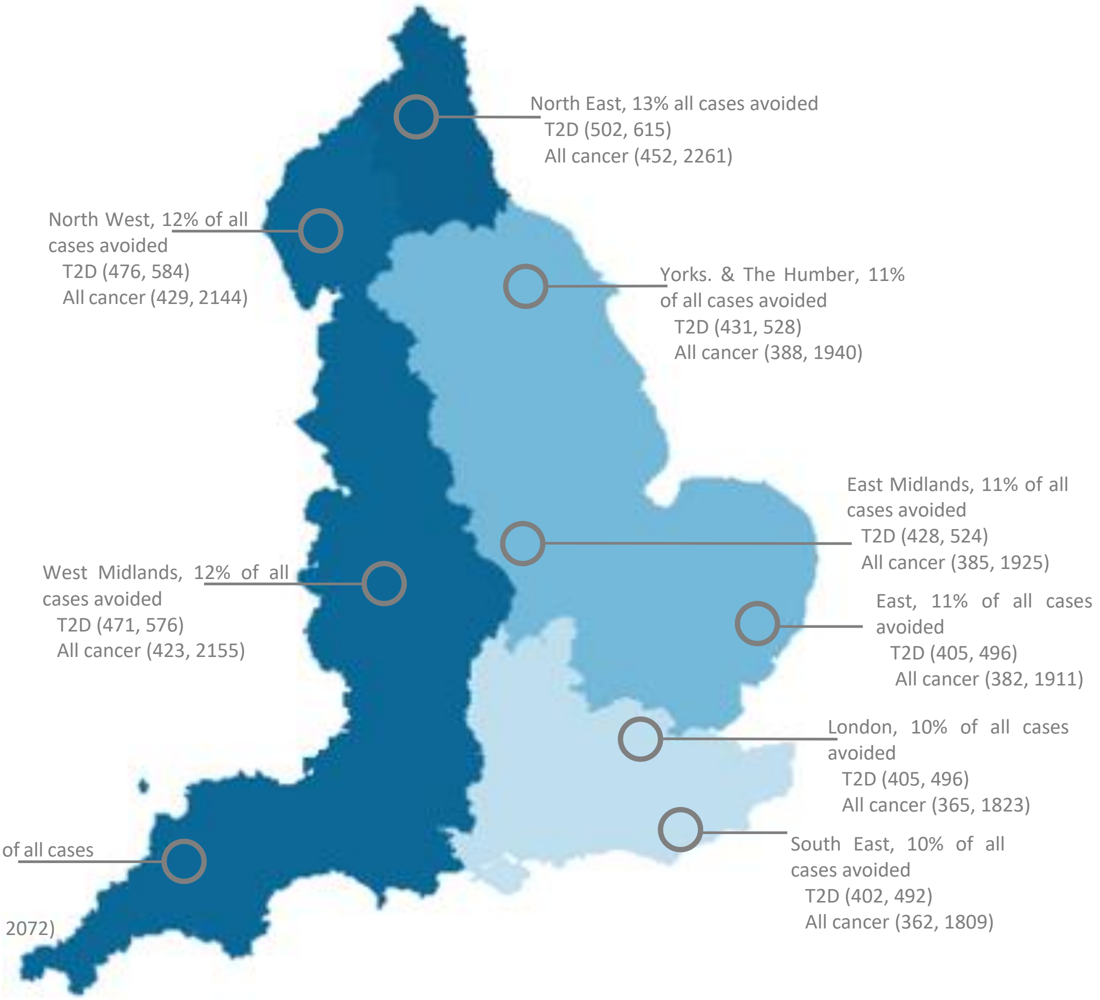


Table 3-2: Distribution of number of cases avoided by region in England (Lower range considered)

Health outcome	North East	North West	Yorkshire & The Humber	East Midlands	West Midlands	East	London	South East	South West
Colorectal cancer	88	83	75	75	82	74	72	70	81

Lung cancer	289	274	248	246	270	244	233	231	265
Ovarian cancer	38	36	32	32	35	32	30	30	35
T2D	502	476	431	428	470	425	405	402	461
All cancers	452	429	388	385	423	382	365	362	414
The benefits from increasing from one to two portions will accrue after 10 years. The number of cases expressed above will be avoided each year, starting from 2030									

Table 3-3: Distribution of number of cases avoided by region in England (Upper range considered)									
Health outcome	**North East**	**North West**	**Yorkshire & The Humber**	**East Midlands**	**West Midlands**	**East**	**London**	**South East**	**South West**
Colorectal cancer	1,244	1,179	1,067	1,059	1,163	1,051	1,003	995	1,139
Lung cancer	1,407	1,334	1,207	1,198	1,316	1,189	1,135	1,125	1,289
Ovarian cancer	100	95	86	86	94	85	82	80	92
T2D	615	584	528	524	576	520	496	492	565
All cancers	2261	2144	1940	1925	2115	1911	1823	1809	2072
The benefits from increasing from one to two portions will accrue after 10 years. The number of cases expressed above will be avoided each year, starting from 2030									

Distribution by age group

Consumption of fish also varies by age group, with younger groups consuming less fish per week on average. The frequency of fish consumption by group was provided in section 2. Adjustment factors have been developed to calculate the distribution of impacts across different age groups, based on the frequency of fish consumption for each age group. The results show:

- ✓ The number of cancer cases avoided for the 25 to 34 age group is estimated to range from 793 to 3,996, larger than for any other age group
- ✓ despite the variation of T2D between age groups is smaller among groups, the cases avoided per year for the 25 to 34 is estimated to range from 881 to 1,080 cases avoided.
- ✓ Those above 55 years of age will experience a fewer 645 cancer cases and 717 T2D, in a best case scenario.

Thus, based on current consumption levels by age, the health benefits may be larger among younger generations if seafood consumption increased (as those groups are expected to increase the weekly seafood consumption from one portion to two). The largest benefit will accrue to the 25 to 34 years group, currently consuming less fish than other age categories. The number of cases of ill-health avoided are set out in the next tables, taking into account the lower and upper range each time.

Table 3-4: Distribution of number of cases avoided by age group per year (Lower range considered)					
Health outcome	**18-24**	**25-34**	**35-44**	**45-54**	**55+**
Colorectal cancer	142	154	139	140	125
Lung cancer	465	507	456	460	412
Ovarian cancer	60	66	60	60	54
T2D	810	881	794	798	717
All cancers	729	793	714	719	645
The benefits from increasing from one to two portions will accrue after 10 years. The number of cases expressed above will be avoided each year, starting from 2030					

Table 3-5: Distribution of number of cases avoided by age group per year (Upper range considered)					
Health outcome	**18-24**	**25-34**	**35-44**	**45-54**	**55+**
Colorectal cancer	2,004	2,181	1,965	1,976	1,774
Lung cancer	2,267	2,467	2,223	2,236	2,007
Ovarian cancer	162	176	159	Q60	143
T2D	992	1,080	972	978	878
All cancers	3,463	3,966	3,572	3,593	3,226
The benefits from increasing from one to two portions will accrue after 10 years. The number of cases expressed above will be avoided each year, starting from 2030					

3.4 Discussion

A review of the potential benefit of fish in the diet, highlights that including fish in the diet produces several health benefits, particularly when compared to meat. These benefits stem mostly from weight control and reduced risk of being overweight, as fish is a lean source of protein with lower fat content.

The results and the evidence are of different strengths across the different health outcomes however. The literature review has revealed strong evidence on the links between diets and specific health outcomes such as colorectal cancer, lung and ovarian cancer and T2D. Generally, there is enough evidence that processed meat and red meat can increase the probability of developing these types of cancer and T2D, and that a more balanced diet can reduce it. However, this study does not suggest stopping eating meat all together, but that if the consumption is high, this may be replaced with a fish alternative.

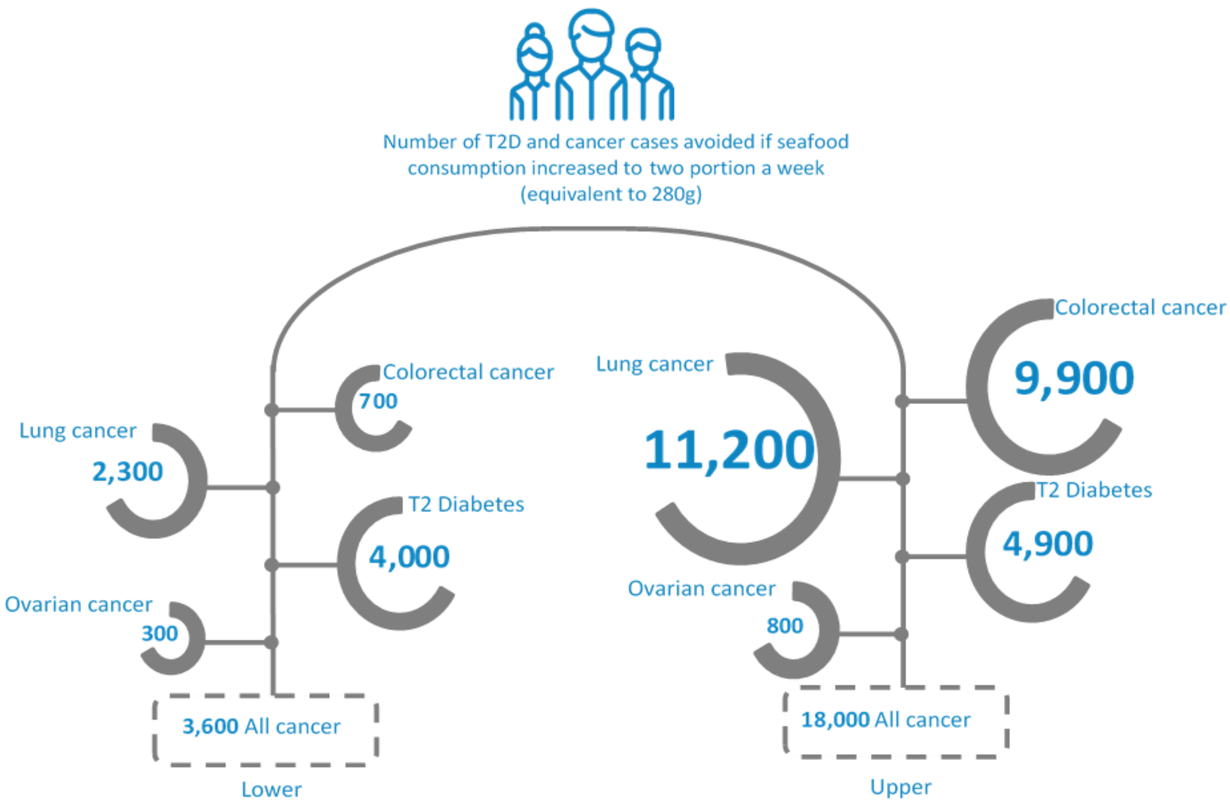
The literature review presented above shows the most robust studies showing a positive link between fish consumption and a reduction in the risk of developing specific illnesses. These studies have been used to estimate the health outcomes from increased fish consumption. Other evidence that has been found to be less robust (based on statistic and population sizes) have been excluded. However, the evidence is developing rapidly and more evidence may developed in the future concerning different fish species and other health conditions. It is important to note that adverse effects such as mercury poisoning were outside the scope of this study. It has not been possible to model the cooking methods into the nutritional value and impacts on health either.

Last but not least, and for modelling purposes, the study has assumed that the current level of veganism and vegetarianism continues, and that vegans and vegetarians will not change their diet thus with no increase in fish consumption for these groups. Current trends however suggest an increase in veganism and vegetarianism (BBC, 2020[32]), so that that the number of cases avoided for the different health outcomes, following an increase in fish consumption as presented above, may overestimate the impacts. On the other hand, there appears to be evidence suggesting that a small but growing number of people in the UK are choosing a pescatarian diet, in which they eat a vegetarian

[32] Jones L, BBC News **(2020):** Veganism: Why are vegan diets on the rise?, available at: https://www.bbc.co.uk/news/business-44488051

diet while adding in fish and shellfish[33]. According to a recent survey, 7% of adults are pescatarian and pescatarianism is set to grow by 80% (Johnson GR, 2020[34]).

'All cancer types' includes different cancer codes (C00-C97). Modelling was possible for specific cancer types where evidence was more robust (lung, ovarian and colorectal). The modelling suggests that most cases avoided are expected for lung and colorectal cancer cases. Other modelling for other cancer types could not be undertaken due to scarcity of more robust data.



[33]SeafoodSource (2016): **Pescetarianism a fast-growing trend to watch, available at:** https://www.seafoodsource.com/news/foodservice-retail/pescetarianism-a-fast-growing-trend-to-watch

[34] Johnson Gr (2020): UK Diet trends 2020, available at: https://www.finder.com/uk/uk-diet-trends. Based on a survey of 2,000 adults to investigate the diet habits and intentions of UK residents.

4 The socio-economic impacts from increased seafood consumption

4.1 Introduction

This section presents the estimates of the socio-economic impacts from increasing seafood consumption, based on different values found in the literature on the costs of ill-health and the number of cases avoided presented in the earlier section.

The literature review has included a review of different metrics to value the impacts of reduced ill-health and mortality across the English population. There are different costs associated with different health outcomes related to, not only the healthcare costs of treatment, but also the burden to patients from being in poor health conditions (measure as loss of utility). The model and the values used to estimate the socio-economic impacts is further described in the Technical Annex, Annex 1.

There are also economic impacts not related to human health such as changes in consumers' weekly expenditure from replacing other food sources with seafood. These are compared against the socio-economic benefits gained from better diets and reduced ill-health and mortality. The analysis on increased expenditure is based on current expenditure and consumption of different meat types (poultry and non-poultry), as described in section 2, to replace one portion of meat with fish, as this is the most likely replacement.

The economic impacts from increasing fish consumption can be thus divided into:

- Avoided direct costs:
  - Direct healthcare costs: these can be derived from NHS Reference costs (in-patient) and Unit Costs of Health and Social care, as derived by the PSSRU.
  - Direct non-healthcare costs: the principal cost is that to the consumer of purchasing fish compared to its likely alternative (meat). This will be derived from consumer statistics as identified during literature review.
- Avoided indirect costs:
  - Indirect healthcare costs: these costs include the time and resources devoted to caring for patients outside the health care system, e.g. by family members, and must be estimated based on socio-economic evidence from literature review.
  - Indirect non-healthcare costs: these include lost/gained productivity as a result of being able/unable to work. They may be short-term (time to attend appointments, the cost of which is borne mainly by the employer) or longer term (long-term sick leave, borne by the patient or government in social security benefits). In addition, reduced mortality in economically active groups may have an effect on productivity in the wider economy.
- Avoided intangible costs such as reduced quality of life.

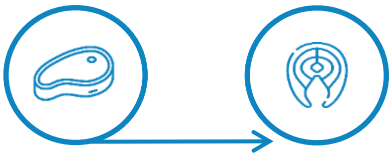
4.2 Direct cost to the consumer from increasing seafood consumption

There may be some costs to the consumer from consuming two portions of fish per week compared with current protein consumption costs given that specific types of fish, are generally more expensive than other protein sources. In this section, we discuss the changes in the cost to the consumer after increasing the weekly fish consumption from one to two portions (280 g per week).

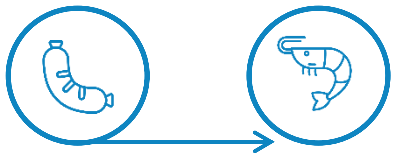
The current consumption levels of other protein sources have been taken into account as well as current expenditure. For the purpose of these calculations, we are assuming that the consumer is a meat eater and that one portion of meat, poultry and fish is equal to 140 g. The following table shows the changes in costs from moving from one portion of fish to two portions of fish for different scenarios related to different changes in diet, namely:

- Replacing one portion of carcass meat for one portion of fish: carcass meat includes beef, pork, mutton and lamb.
- Replacing one portion of chicken for one portion of fish.
- Replacing one portion of other meat, non-carcass with fish. Meat under this group include sausages and processed meat, such as bacon, burgers, ham, pies, cooked and canned meat.

The costs have been developed from current baseline consumption and expenditure, as described in section 2. As it can be seen from Table 4-1, the increase in costs to consumers may vary according to current consumption, what they switch from but also the type of fish they will be buying. Changes from meat other than chicken to rich oil fish could result in weekly savings. Changes in the diet with the smallest cost implications for consumers will be from an increase in one portion a week of herring and/or oil rich species that are similarly priced. Moreover, this may in turn result in savings to households if replacing red or processed meat with these fish species. The findings reveal:



Consumers could save **70p a week** if moving from beef or lamb to herrings or other oil rich fish



Replacing sausages with shellfish will only cost an additional **90p a week**

On the other hand, it seems unlikely that vegetarians will change their eating habits and as such, these costs have not been presented.

Table 4-1: Costs to consumers from changes in diet (additional costs to individual consumers per week, £) -from one portion of fish to two portions/meat eaters in England

Increase in one portion across England	To herring and other oil rich fish	To white fish	To salmon	To shellfish
From carcass meat	-0.70	0.32	0.58	0.81
From chicken	0.15	1.16	1.42	1.65
From non-carcass meat	-0.60	0.42	0.67	0.90
Carcass meat includes beef and veal, mutton and lamb, pork Non-carcass meat includes liver, bacon, ham, sausages, ready meals and convenience meat				

Table 4-2 shows the weekly expenditure and percentage change in costs for English consumers from changes in diet, based on current average consumption and expenditure. The average expenditure in food and drink across England was £27.53 per person per week, the largest share being on non-carcass meat. It may thus be logical to assume that a meat eater may replace processed meats with fish, as an additional average cost per week of £0.35 per person (average across all types of fish).

Table 4-2: Average increase in expenditure for England			
Replacement type	**New weekly expenditure per person (£)**	**% change in weekly expenditure**	**New yearly expenditure per person**
From carcass meat			
To white fish	4.38	8%	227.8
To herring	3.36	**-17.2%**	174.8
To salmon and trout	4.64	14.2%	241.2
To shellfish	4.87	19.8%	253.1
From poultry			
To white fish	5.23	28.7%	271.8
To herring	4.21	3.6%	218.8
To salmon and trout	5.48	35.0%	285.2
To shellfish	5.71	40.6%	297.1
From non-carcass meat			
To white fish	4.48	10.3%	232.9
To herring	3.46	**-14.8%**	180.0
To salmon and trout	4.74	16.6%	246.3
To shellfish	4.97	22.3%	258.3

Across England, the additional consumer expenditure is therefore estimated to top £15m per week (excluding vegetarians which represent 4% of the total population over 18 years of age[35]). However, this may be an overestimate as it would be unlikely that all individuals will increase their consumption of fish. The recent One Pulse survey conducted by Seafish revealed that 35% of the respondents do not wish to eat more fish and 65% will increase consumption. Applying a more conservative figure of 65% to the total costs, for those willing to increase consumption, will mean a £10m increase in weekly food expenditure is therefore estimated for England (on the assumption that 65% of the population will replace non-carcass meat with a variety of fish) or £520m annually.

Because the current patterns vary across regions and age groups, the financial costs will vary geographically and by age. The distribution of total costs has thus been adjusted to account for this.

Distribution by geographical location

Currently, consumption of different kinds of meat vary by region. However, in every region the weekly consumption of the different meat types (carcass meat, chicken and poultry and non-carcass meat) exceed the recommended level of 70 g per day, as shown by the Family Food Survey and depicted in Table 4-3 below. The survey shows that:

The North East is, not only the region eating less seafood across England (18 gr per day) but also, the region eating the largest amount of processed meat (or non-carcass);

London consumption of non-carcass meat is far below any other region in England but the largest when it comes to fish consumption (155grams per week or 22gr a day).

[35] N=44,022,560 (2018 estimates for England).

Table 4-3: Current consumption level of meat (g per day) by English region – average (2015/2017)									
Type of meat	North East	North West	Yorkshire & the Humber	East Midlands	West Midlands	East	London	South East	South West
Carcass meat	26	25	26	30	28	28	26	28	28
Chicken and other poultry	28	30	29	28	31	32	30	28	31
Non-carcass meat	88	87	84	83	78	80	54	77	82

Table 4-4 presents the average expenditure after the increase in fish consumption from one to two portions per week. The distribution of the costs is shown by region.

Table 4-4: Average weekly expenditure of the consumer after the intervention (for 280g of fish per week)									
Food category \Region	North East	North West	Yorkshire & the Humber	East Midlands	West Midlands	East	London	South East	South West
From carcass meat									
To white fish	4.10	4.24	4.71	4.57	4.38	4.56	4.19	4.56	4.31
To herring	2.89	3.14	3.71	3.58	3.30	3.57	3.25	3.62	3.26
To salmon and trout	4.41	4.52	4.96	4.83	4.66	4.81	4.43	4.79	4.58
To shellfish	4.68	4.77	5.19	5.05	4.90	5.03	4.65	5.00	4.81
From Poultry									
To white fish	5.11	5.16	5.54	5.40	5.29	5.37	4.98	5.34	5.18
To herring	3.89	4.05	4.54	4.41	4.20	4.39	4.03	4.40	4.13
To salmon and trout	5.41	5.44	5.79	5.65	5.56	5.62	5.22	5.57	5.45
To shellfish	5.68	5.68	6.02	5.87	5.81	5.84	5.43	5.79	5.68
From non-carcass meat									
To white fish	4.22	4.35	4.81	4.67	4.49	4.65	4.28	4.65	4.41
To herring	3.00	3.25	3.81	3.68	3.40	3.67	3.34	3.71	3.37
To salmon and trout	4.52	4.63	5.06	4.92	4.76	4.90	4.52	4.88	4.68
To shellfish	4.80	4.88	5.29	5.14	5.01	5.12	4.74	5.28	4.91

Table 4-5 presents the abovementioned change in the weekly costs to the consumers, expressed in percentages. In every region, the cost to the consumers is higher when the consumers substitute other protein sources with shellfish. The average spend on food however can be reduced if shopping for other fish varieties such as herring and rich oil rich fish (shown in bold in Table 4-5).

Substitution of poultry with shellfish is costly in the North East of England (52.8% increase in cost) but the increase in cost is lower if shellfish substitutes carcass meat (the change in cost is almost half of the increase in cost followed by the substitution of poultry with shellfish). In particular the table shows that replacing meat with shellfish is consistently the most expensive choice across all regions and particularly if replacing chicken. Currently consumers in England favour white fish, followed by salmon and trout and rich-oil fish, as described in Section 2. Thus, the findings show:

There could be costs savings in consumer expenditure above 10% if replacing meat, other than poultry, with oil rich fish which is proven to have health benefits across all regions in England.

By region, the North East could see the largest reduction in weekly expenditure should consumers wish to replace meat with oil rich fish, with the average expenditure reduced by nearly 20%.

Table 4-5: Change in costs - average expenditure per consumer per week

Food category \Region	North East	North West	Yorks. & the Humber	East Midlands	West Midlands	East	London	South East	South West
From carcass meat to:									
White fish	10%	9%	7%	7%	8%	7%	8%	7%	8%
Herring	**-22%**	**-19%**	**-16%**	**-16%**	**-19%**	**-16%**	**-17%**	**-15%**	**-18%**
Salmon and trout	18%	16%	13%	13%	15%	13%	14%	13%	15%
Shellfish	26%	22%	18%	18%	21%	18%	19%	17%	21%
From poultry to:									
White fish	37%	32%	26%	27%	31%	27%	28%	25%	30%
Herring	5%	4%	3%	3%	4%	3%	4%	3%	4%
Salmon and trout	46%	40%	32%	32%	38%	32%	34%	31%	37%
Shellfish	53%	46%	37%	38%	44%	38%	40%	36%	43%
From non-carcass meat to:									
White fish	13%	12%	9%	10%	11%	10%	10%	9%	11%
Herring	**-19%**	**-17%**	**-13%**	**-14%**	**-16%**	**-14%**	**-14%**	**-13%**	**-16%**
Salmon and trout	22%	19%	15%	15%	18%	15%	16%	15%	17%
Shellfish	29%	25%	20%	21%	24%	21%	22%	24%	23%

Distribution by age group

As shown in Section 2, the current fish consumption also varies by age group. The Family Food Survey does not provide details of average meat consumption by age group so an alternative approach has been used. This consists of applying the additional average cost per week of £0.35 per person (average across all types of fish) from one to two portions applied to current population groups and frequencies in levels of consumption (or double the amount for a double portion increase).

The following table shows that the additional expenditure is slightly larger for 25 to 34 year olds, which is not unsurprising owing to the largest share of consumers eating less fish than in other age groups (with the exception of those not eating fish in the group 18 to 24). However, due to the age distribution of English population, the results shall be interpreted with caution when aggregated (i.e. approximately 17m of English adults are over 55+ years and only 5m in the youngest age category).

Table 4-6: Change in weekly costs by age group					
Frequency	**18-24**	**25-34**	**35-44**	**45-54**	**55+**
Once a week	22%	29%	26%	27%	28%
Less than once a week (includes don't knows)	38%	37%	34%	34%	26%
Never eat fish	16%	11%	13%	10%	4%
Population estimates in each group (ONS) for England	5,078,884	7,998,302	7,460,856	7,317,459	17,850,836
Excl. vegetarians	4,875,729	7,678,370	7,162,422	7,024,761	17,136,803
Additional expenditure per week - 1 additional portion across all population	375,000	779,000	652,000	664,000	1,679,000
Additional expenditure per week - 2 additional portions across all population	142,000	263,000	213,000	204,000	348,000
Additional expenditure per week (£) average across group	**0.11**	**0.14**	**0.12**	**0.12**	**0.12**

For all age groups and based on current consumption, consumers will not exceed 20 pence additional costs per person per week if increasing their seafood portions to two a week.

4.3 Socio-economic impacts from health outcomes

The results of the socio-economic assessment are summarised below, for the lower and upper range of the cases avoided. These represent the multi-year costs avoided through reduced incidence in a single year of the relevant effects. In other words, these are the costs from the avoided cases diagnosed in a single year, which would have resulted in healthcare, informal care, productivity costs, and reduced quality of life over many years starting in 2030[36]. The benefits summarised below, include direct healthcare costs incurred by the NHS, indirect healthcare costs (in terms of informal care offered by family), productivity losses, loss of working days and loss of quality of life (measured as QALYs).

Table 4-7: Summary of benefits from increased consumption - avoided costs of reduced annual incidence across all stakeholders over the lifetime of consumers	
Health outcomes	**£ (in millions)**
Lower range of cases considered	
Colorectal cancer	£92
Lung cancer	£494
Ovarian cancer	£39
All cancer	£515
T2D	£745

36 For example, it is expected that 4,000-4,900 fewer cases of T2D would be diagnosed in 2030 if two portions of fish are consumed each week by the whole of England's population. If not avoided, these 4,000-4,900 cases would result in healthcare and productivity costs and suffering for around 30 years (2030-2059) and all of these patients would also die prematurely (for modelling purposes, they are expected to die in 2059).

Table 4-7: Summary of benefits from increased consumption - avoided costs of reduced annual incidence across all stakeholders over the lifetime of consumers	
Health outcomes	**£ (in millions)**
Lower range of cases considered	
Upper range of cases considered	
Colorectal cancer	£1,307
Lung cancer	£2,371
Ovarian cancer	£124
All cancers	£2,576
T2D	£915

Costs by stakeholder category

The benefits for the different stakeholders are depicted in Table 4-8 for the different health outcomes. As seen, the largest benefits are for patients and consumers in terms of loss in quality of life and indirect healthcare costs. For the lower range, the largest benefit will be from reduced T2D cases; whereas for the upper range, the largest will be from reduced cancer .

Table 4-8: Summary of avoided costs by stakeholder group - avoided costs of reduced annual incidence per year (in millions)			
Health outcomes	**Patients/consumers and their families**	**Governments/NHS**	**Businesses**
Lower range of cases considered			
Colorectal cancer	£75	£12	£8
Lung cancer	£394	£54	£28
Ovarian cancer	£31	£5	£3
All cancers	£411	£72	£43
T2D	£435	£196	£114
Upper range of cases considered			
Colorectal cancer	£1,059	£166	£119
Lung cancer	£1,890	£258	£135
Ovarian cancer	£100	£16	£10
All cancers	£2,054	£360	£216
T2D	£535	£241	£140

The impacts from increasing seafood consumption in England by group

£270m-£600m savings to the NHS for preventable cases a year

- £196m-£241m savings to the NHS from preventable cases of T2D a year
- £72m-£360m savings to the NHS from preventable cancer cases a year

Consumers will benefit from better quality of life and reduced need for care for family members and these socio-economic benefits are estimated at £0.8bn- £2.6bn annually

- £435m-£535m from preventable cases of T2D a year
- £411m-£2,054m savings to the NHS from preventable cancer cases a year

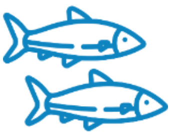
£157-£356m benefits to business from reduced absenteeism per year, linked to better health of workers eating 1 more portion of fish a week

5 Summary of findings

5.1 Overview of main findings

The objective of this study is to review the current evidence on health outcomes in order to assess the economic impacts from increasing fish consumption to two portions a week, following recommendations from the NHS.

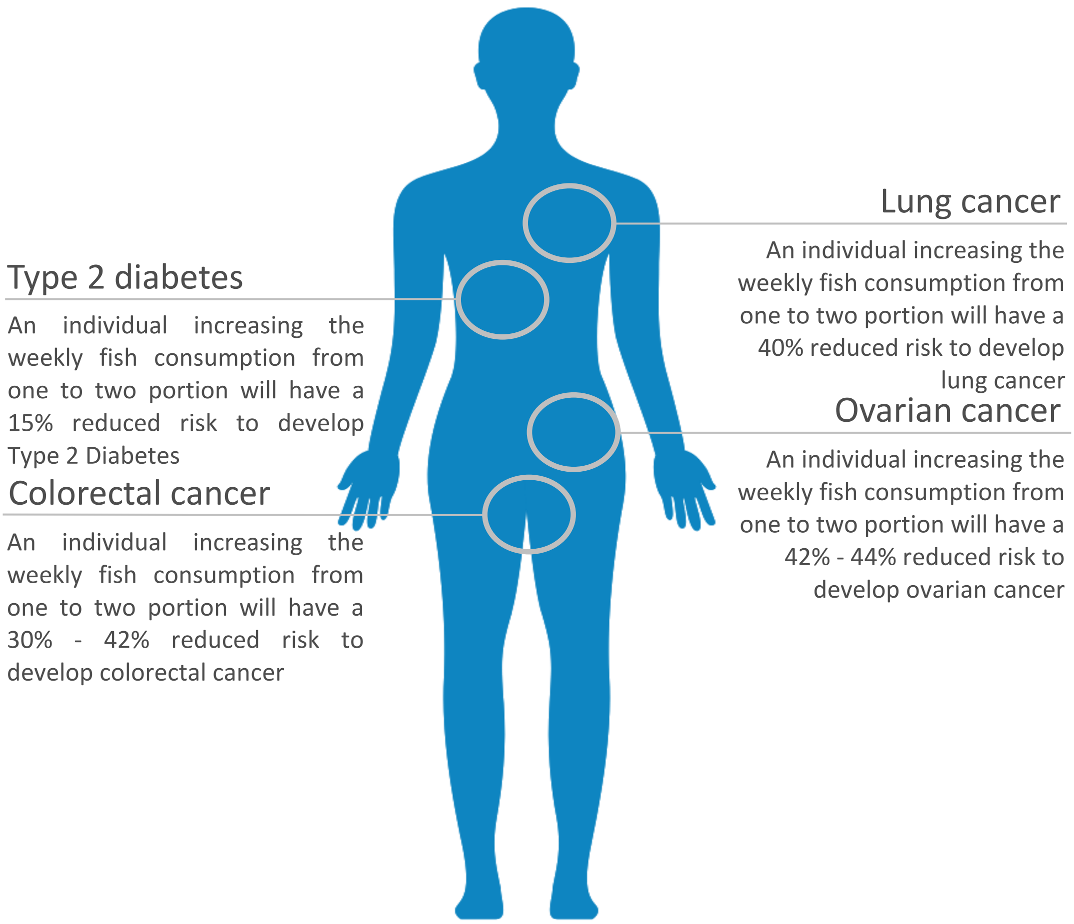
Current evidence suggests that the amount of fish that people are eating has steadily decreased. The 2019 One Pulse Survey commissioned by Seafish found that among the main reasons stopping people from eating fish were that fish expensive. However, this study has revealed that the increase in costs to the consumer per week will not exceed £2 if increasing seafood consumption by one portion, whilst cheaper alternative fish options could result in savings to the consumers.



More importantly, fish however is part of a healthy diet. NHS guidelines recommend that '*a healthy, balanced diet should include at least two portions of fish a week, including one of oil rich fish*'. Preventable diseases related to diet are putting an increasing pressure on health budgets but this pressure can be minimised with very small changes to the diet, such an increase of fish consumption by one portion a week.

The literature review has revealed robust evidence on the health benefits for number of health outcomes, namely:

- Colorectal cancer;
- Lung cancer;
- Ovarian cancer; and
- Type 2 Diabetes (T2D).



Evidence on other health outcomes is considered to be weaker. This is not necessarily because of the lack of robustness of the studies reviewed but because of the low number of studies overall and the differences in the formulation of the analysis. Results of the model show a significant decrease in number of cases over the lifetime of patients.

All cancers: 3,600 to 18,000 could be avoided per year if increasing seafood consumption to two portions a week (considering mortality rates, this will be equivalent to 1,700 to 8,500 lives saved).

Type 2 diabetes: 4,000 to 4,900 cases could be avoided per year if increasing seafood consumption to two portions a week (with the risk of dying prematurely).

5.2 Comparing the costs and the benefits

The benefits from improved health will entail savings in healthcare costs to both the NHS and government. Savings to the economy will accrue in terms of productivity gains. There will also be improvements in the quality of life of consumers, from less ill-health episodes. These will have to be compared with the additional costs from changes in the diet to more expensive sources of protein. Generally, however, it is expected that the benefits will far outweigh the costs to consumers.

The net socio-economic impacts from increasing seafood consumption to one more additional portion a week across the English population can be valued at between £14.5m and £58.2m per week in benefits (avoided T2D and all cancer cases and including mortality).

A summary and overview of costs and benefits are provided below.

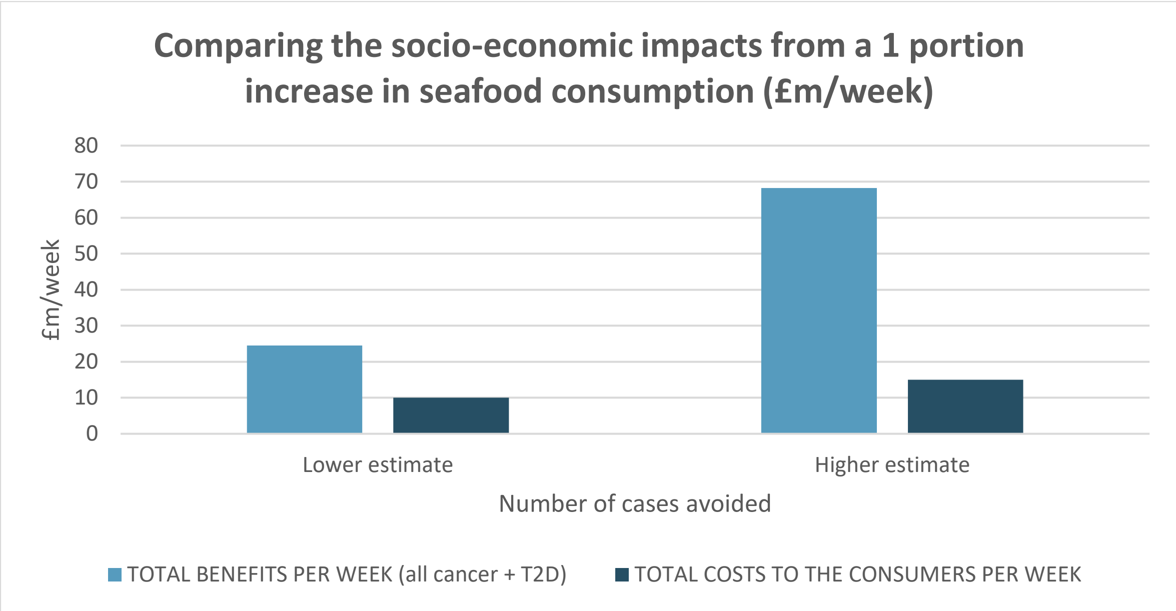


Table 5-1: Summary of avoided costs and benefits by stakeholder group per week (£ million)

Health outcomes	Patients/consumers and their families	Governments	Businesses
Lower range of cases considered			
Colorectal cancer	1.4	0.2	0.2
Lung cancer	7.6	1.0	0.5
Ovarian cancer	0.6	0.1	0.1
All cancer	7.9	1.4	0.8
Type 2 diabetes	8.4	3.8	2.2
Total benefits per week (all cancer + T2D)	16.3	5.2	3.0
Total costs to the consumers per week	**10m**		
Upper range of cases considered			
Colorectal cancer	20.4	3.2	2.3
Lung cancer	36.3	5.0	2.6
Ovarian cancer	1.9	0.3	0.2
All cancer	39.5	6.9	4.2
Type 2 diabetes	10.3	4.6	2.7
Total benefits per week (all cancer + T2D)	49.8	11.6	6.8
Total costs to the consumers per week	**15m**		

Previous Sections compare the costs and benefits of increasing the consumption of fish by one portion a week. The following table summarises the impact on a weekly basis, both costs and benefits. As shown, the benefits are expected to exceed the costs to the consumers on a weekly basis, for both consumers and more so for the whole of the economy (including governments and businesses). By health outcomes, the largest benefits are expected to stem from the reduction of T2D.

The above Sections also show however that the distribution of health outcomes and costs may be different for the different regions and groups. In particular:

- the average consumption of fish is higher in London and the South East and the smallest portions are on average consumed in the North East, North West and the West Midlands. The benefits from increasing consumption may be larger in the latter regions and the largest benefits will accrue in the North East where consumption is at its lowest; and
- younger groups are consuming less fish per week on average. The largest benefit will accrue to the 25 to 34 years group, currently consuming less fish than other age categories. Nearly half of those over 55 are currently consuming 2 portions of fish a week.

5.3 Recommendations for future research

Although there is an obvious link between healthy eating and an improvement of health, the evidence is not always conclusive on the link between fish consumption and specific health outcomes. In particular, further research is needed on the following health outcomes:

- Prostate cancer;
- Breast cancer;
- Heart failure;
- Coronary Heart Disease (CHD); and
- Kidney effect.

Other outcomes such as mental health could also be added to the above list. Depression is more common among people who are obese but it could also be that complications associated with obesity, such as T2D, are contributing to depression rather than the obesity itself (NHS, 2018). Previous studies have not been able to determine whether there is a direct cause and effect relationship. The links between healthy eating and mental health are only now starting to be explored in greater depth.

Moreover, the linkages between the different health outcomes may need exploring, should any figure be produced in aggregate. This is because of aspects to do with co-morbidity. Our study has produced a conservative estimate based on incidence across all cancers to account for this. However, in doing so, it may be that we have underestimated the total benefits from increasing seafood consumption.

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Health and Safety Executive: http://www.hse.gov.uk/

MacMillan: https://www.macmillan.org.uk/

NHS: https://www.england.nhs.uk/

NICE: https://www.nice.org.uk/

Annex 1 : Technical annex on methodology

A1.1 Overview

The following Figure A1-1 provides an overview of our approach. This has included both a review of the literature and a modelling approach, according to the scope of the study agreed at the kick-off meeting. The scope of this study excludes the following type of impacts:

- Environmental impacts from increased fishing activity: it is assumed that fishing follows best practice and the impacts from fishing are within sustainable bounds;
- Economic impacts on the fishing industry, including the processing, and employment effects from increased seafood production; and
- Health outcomes with minimal incidence but also those related to fish poisoning from specific contaminants, such as heavy metals and plastic contaminants. These types of impacts are described but are not included in the modelling exercise.

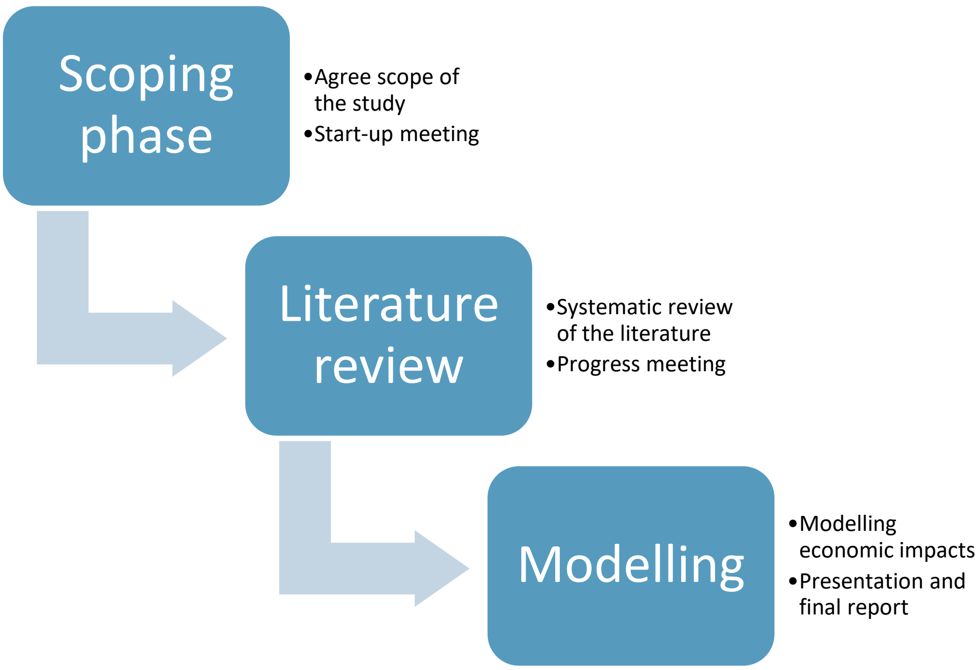

Figure A1-1: Overview of the approach used to carry out this research

A1.2 Literature review on health outcomes

The review of the literature was conducted by the HEC following methods recommended for rapid assessment, screening, and systematic reviews to ensure robustness. A protocol was developed to assist with the selection of references based on the scope of the study, as agreed, according to a set of criteria. Criteria for including studies were predefined based on the PICO elements (Population, Interventions, Comparators, Outcomes) and are detailed in Table A-1. The rapid assessment and review included adult studies conducted in the UK and similar western countries or Australia/New

Zealand but excluded studies in Asia. These were thought to be less transferable on the basis of genetic and dietary differences.

Table A-1: The PICOS table

Study Characteristics	Inclusion criteria	Exclusion criteria
Population	- UK population - European and North American (if needed) - Australia. - Adults (≥18yrs) - Pregnant women	- Other regions including Asia - Children and adolescents (<18yrs)
Interventions/ Comparators	- Increased seafood consumption - Current consumption levels of seafood in England (i.e. 150 g per week, equivalent to 1.08 portions) - Secondary analysis: omega-3s and any other components of fish to which its benefit may be attributed	
Outcomes	- Health outcomes. This will include both positive (cardiovascular, diabetes etc.) and negative effects (poisoning)	
Study design	- Systematic literature reviews & meta-analyses - Experimental (though likely limited) – may be some on omega-3 or other constituents of fish that are beneficial - Observational studies - Economic evaluations – CEA, CUA, CMA, CBA.	- Case reports - Letters - News - Editorial - Comments etc.
Restrictions	- English language - Time limits (2008 - 2019)	

The sources of data for modelling the health outcomes, are epidemiological studies investigating the incidence rate of diseases in population linked to dietary factors. Epidemiological evidence can only show that this risk factor is associated (correlated) with a higher incidence of disease in the population exposed to that risk factor. The higher the correlation the more certain the association, but higher correlation alone cannot prove the causation between incidence rate of disease and dietary factors.

There are different types of epidemiological studies. In cohort studies, the investigator typically selects a group of exposed and a group of unexposed individuals and follows both groups over time to determine disease occurrence in relation to the exposure. A number of cohort studies have been found following the health effects from eating different foods. The differences in health effects are measured with hazard ratios, comparing the probability of events in the different groups. What the "event" is depends on the type of study. For example, it may be death, stroke, cancer, etc. The hazard ratios, which are defined as the relative risk of an event happening, can be interpreted as follows:

- A hazard ratio of 1 means that both groups are experiencing an equal number of events at any point in time.
- A hazard ratio of 0.333 tells you that the hazard rate in the treatment group is one third of that in the control group.
- A hazard ratio of 3 means that three times the number of events are seen in the treatment group at any point in time.

In our model, Hazard ratios have been used to estimate the reduction in incidence of specific health outcomes related to increased fish consumption. The different health outcomes investigated in our research, and assumptions are explained below. The proposed pivotal assumptions included in the model are as follows:

- Adverse events, including mercury poisoning, and the potential effects of ingestion of microplastics will not be modelled, as an assumption is made that safe levels of fish consumption will not be exceeded, and pregnant/lactating women will adhere to government guidelines in this respect;
- The consumption of two portions of fish per week will continue for the lifetime of the included population; and
- The consumption will follow the NHS recommendations of two portions, one of which is oil rich fish on the assumption that this diet will maximise the health benefits. The literature review however is not always detailed on the specific type of fish, so it has not been possible to model for this in the estimation of health outcomes.

Following the initial review of the literature it was decided that the approach to the model for this research will be that by Taylor (2018), investigating the health benefits from increased physical activity[37]. This study was considered to be of relevance, as it compares similar health outputs and is also based on UK population groups.

The different literature and health outcomes are detailed below in Section 3 with reference to the current incidence rates in the UK. Incidence rates and projections are also presented by health outcome below to put the impacts into context.

Moreover, some of the health outcomes can co-exist. Comorbidity refers to the presence of more than one disorder in the same person, e.g. diseases of the respiratory systems such as asthma or chronic progressive conditions like cardiovascular disease (CVD). People with diabetes are more likely to experience heart failure or heart attack (2.5 times) or stroke (2 times). Similarly, more ill-health may affect mental conditions. It has not been possible to model for co-morbidity effects within the study. This also reduces the risk however of double-counting. Moreover, this study has taken a precautionary approach to modelling by combining all cancer cases into a single estimate and presenting those where the evidence is more robust separately. Different estimates have also been produced for T2D. Lower and upper estimates have been generated to reflect uncertainty.

It is expected that the high nutritional value of fish will result in health benefits. The following Table details the level of nutrients of different type of fish. As it can be seen from the Table, oil rich fish is a good source of Vitamin D, helping to regulate the amount of calcium and phosphate in the body. Oil rich fish include includes:

- herring (bloater, kipper and hilsa are types of herring)
- pilchards
- salmon
- sardines
- sprats
- trout
- mackerel.

[37] Taylor, M. and No, P. (2018) 'National Institute for Health and Care Excellence: Physical activity and the environment. London: National Institute for Health and Clinical Excellence; 2008.', (January). Available at: https://www.nice.org.uk/guidance/ng90/evidence/economic-modelling-report-pdf-4788819757 on 3rd October 2019

Table A-2: Top 5 fish and fish dishes with the highest levels of nutrients

Macronutrients					Micronutrients								
Protein g/100g	**Energy (kcal)/100g**	**Cis-n3 fatty acids g/100g**	**Cis-n6 fatty acids g/100g**	**Cholesterol milligrams/100g**	**Vitamin A micrograms/100g**	**Vitamin D micrograms/100g**	**Vitamin E milligrams/100g**	**Vitamin B12 micrograms/100g**	**Calcium milligrams/100g**	**Phosphorus milligrams/100g**	**Copper milligrams/100g**	**Zinc milligrams/100g**	**Selenium micrograms/100g**
Tuna, baked, flesh only (32.3)	Mackerel, smoked (301)	Mackerel, smoked (5.57)	Calamari, coated in batter, baked (9.51)	Crab, brown meat, purchased cooked (271)	Mussels, purchased cooked (117)	Salmon, pink, canned (13.59)	Crab, brown meat, purchased cooked (7.33)	Crab, brown meat, purchased cooked (22.4)	Sardines, canned in brine (679)	Sardines, canned in brine (545)	Crab, brown meat, purchased cooked (2.49)	Crab, white meat, purchased cooked (7.23)	Crab, brown meat, purchased cooked (225)
Salmon, smoked (hot-smoked) (25.4)	Calamari, coated in batter, baked (288)	Mackerel, grilled, flesh only (4.83)	Tuna, canned in sunflower oil (3.43)	Prawns, king, warm-water (Penaeus vannamei), purchased cooked (162)	Fish pie, white fish, retail, baked (84)	Salmon, red, canned, skinless and boneless (11.82)	Prawns, cold-water (Pandalus borealis), purchased cooked (3.63)	Kippers (analysed without butter), grilled, flesh only (11.12)	Sardines, canned in tomato sauce, whole contents (455)	Crab, brown meat, purchased cooked (488)	Crab, white meat, purchased cooked (0.95)	Crab, brown meat, purchased cooked (5.9)	Tuna, raw, flesh only (93)
Tuna, canned in sunflower oil (25.4)	Mackerel, grilled, flesh only (283)	Mackerel, raw, flesh only (4.05)	Plaice, coated in breadcrumbs, baked (3.19)	Prawns, king, warm-water (Penaeus vannamei), raw (150)	Tuna, baked, flesh only (78)	Kippers, boil in the bag, with butter, cooked (11.15)	Langoustine, boiled (3.55)	Sardines, canned in brine (10.81)	Crab, brown meat, purchased cooked (366)	Sardines, canned in tomato sauce, whole contents (417)	Prawns, king, warm-water (Penaeus vannamei), grilled from raw (0.35)	Mussels, purchased cooked (3.39)	Tuna, baked, flesh only (92)
Tuna, raw, flesh only (25.2)	Fish fingers, salmon, grilled/baked (247)	Mackerel, canned in brine (3.53)	Fish fingers, salmon, grilled/baked (2.66)	Prawns, cold-water (Pandalus borealis), purchased cooked (143)	Tuna, raw, flesh only (76)	Salmon, smoked (hot-smoked) (11)	Plaice, coated in breadcrumbs, baked (3.32)	Mussels, purchased cooked (10.56)	Salmon, red, canned (164)	Salmon, smoked (hot-smoked) (293)	Langoustine, boiled (0.32)	Sardines, canned in brine (2.23)	Crab, white meat, purchased cooked (87)
Tuna, canned in brine (24.9)	Kippers (analysed without butter), grilled, flesh only (245)	Kippers (analysed without butter), grilled, flesh only (3.35)	Fish fingers, cod, grilled/baked (2.61)	Langoustine, boiled (133)	Calamari, coated in batter, baked (64)	Salmon, red, canned (10.9)	Scampi coated in breadcrumbs, baked (3.18)	Mackerel, smoked (10.18)	Langoustine, boiled (125)	Salmon, red, canned (291)	Prawns, cold-water (Pandalus borealis), purchased cooked (0.28)	Sardines, canned in tomato sauce, whole contents (1.98)	Tuna, canned in sunflower oil (87)

Note: Number in () indicates concentration for each nutrient

Source: Information extrapolated from Department of Health (2013): Nutrient analysis of fish and fish products – Summary report. Available at: https://www.gov.uk/government/publications/nutrient-analysis-of-fish on 9th September 2019

Studies had to have compared/analysed data of increased seafood consumption, Omega-3 intake or any other fish components. It also included any beneficial or harmful health outcomes reported by those studies. The following databases were searched to identify relevant studies fulfilling the PICO questions:

- Ovid MEDLINE(R) and Epub Ahead of Print, In-Process & Other Non-Indexed Citations, Daily and Versions(R) 1946 to 10th July, 2019; and
- Embase 1974 to 10th July 2019.

A search strategy was developed using the population terms and incorporating intervention and comparator terms. Afterwards the search was combined with geographical areas and applied the agreed filters and limits as illustrated in Table A3-2.

Table A-3: Search Strategy
Population terms (incorporating fish/sea food consumption, with nutrition, intake or dietary habits, fish oils, omega-3 supplements) **AND**
+ Geographical restrictions (including UK, Europe, North America, Australia, New Zealand) **AND**
+ Study Design filters (excluding case reports, comments, editorials, reports, RCTs) **AND**
+ Additional limits (Language = English only, Time period = published from 2008 to current 2019)

Selecting studies

Search results were exported into a reference manager software, merged and duplicate records were removed. One reviewer assessed titles and abstracts and rejected any clearly irrelevant records (e.g. case studies, studies of children, etc.). Full texts of remaining records were retrieved for further examination. Studies fulfilling the inclusion criteria were included for data collection. For the purpose of expediting the review process, studies reporting on European populations only were prioritised.

A1.2.1 Data Extraction

Data was extracted from all eligible studies using a purpose-developed data collection form. The form collected information about the study name, participants, setting, context, methods, interventions, outcomes, results, as shown in the Table A-4:

Table A-4: Data extraction	
Source • Study ID (created by review author) • Citation and reference details **Eligibility** • Study eligibility criteria including inclusion and exclusion **Methods** • Study design – classify which type • Total study duration/follow up period	**Outcomes** • Outcomes type • Events • Results **Overview** • Study aim/ objectives and conclusion

Baseline characteristics • Total number • Setting • Age • Sex • Country etc. **Interventions** • Specify the type of intervention • Consumption level

A1.2.2 Quality Assessment

Quality of studies included in the review was assessed in two stages. Firstly, based on the PICOS criteria and the suitability and relevance of the study to the UK population in context of the review. For example, studies looking at health outcomes with fish consumption in a UK population were rated 'high' in comparison to studies looking at fish oils/supplementation in UK population as 'moderate' and finally studies looking at fish oils/supplements in non-UK population as 'low'. Secondly a modified STROBE checklist was used to assess the quality of reporting of each study since the studies included were of observational design. Finally, assessments from both checklists were combined together to yield quality as high, moderate or low depending on the overall factors combined.

A1.2.3 Data reporting

Data collected from included studies were tabulated combining study characteristics, available outcome data and quality assessment. Since studies reported on different outcome measures, no formal analysis was carried out.

In order to estimate the proportion of the cohort with each health outcome in each cycle, rather than new cases, we will use the prevalent population data. This population, however, can include a wide variety of patient types and resource uses. For example, type 2 diabetes patients with and without complications, such as retinopathy, neuropathy etc.

A1.2.4 Health outcomes where evidence was found to be robust

The following table, overleaf, summarises the findings where the evidence was found to be the most robust for the calculation of health benefits. The selection criteria included:

- UK cohort studies are preferred.
- Multiple studies are preferred (unless all based on the same data) against health outcomes where only one study is found.
- The type and number of dietary groups included in the study: namely an assessment of health outcomes where on average:
  - regular meat eaters eat 43 g of fish per day, (14 g of which is oil rich fish),
  - low meat eaters eat 40 g of fish per day (16 g of which is oil rich fish),
  - fish eaters eat 40 g of fish per day (16 g of which is oil rich fish), and
  - vegetarians and vegans do not eat fish at all.

Table summarises the relative risks used for the modelling. For every health outcome, the number of cases avoided are calculated by comparing the Health ratios (HRs) for regular – low meat eaters, and

HRs for fish eaters – vegetarians. When regular meat eaters are compared with low meat eaters, the scenario under investigation examines the substitution of one portion of red meat with one portion of fish. The second scenario compares HRs for fish eaters with HRs of vegetarians. The only dietary element separating these two dietary groups is the consumption of seafood. In this way, the scenario investigates the number of cases avoided by adding one extra portion of fish in the diet, in the absence of any other source of substitution. The table below gives the lower and upper range used in the modelling.

Table A-5: Studies selected and the corresponding HRs

Health outcome	Study selected	HR
Colorectal cancer	Appleby et al. 2016	Regular meat eaters: HR= 1 Low meat eaters: HR= 0.96 Fish eaters: HR= 0.61 Vegetarians/Vegans: HR= 1.05
Lung cancer	Appleby et al. 2016	Regular meat eaters: HR= 1 Low meat eaters: HR= 0.88 Fish eaters: HR= 0.57 Vegetarians/Vegans: HR= 1
Ovary cancer	Appleby et al. 2016	Regular meat eaters: HR= 1 Low meat eaters: HR= 0.88 Fish eaters: HR= 0.58 Vegetarians/Vegans: HR= 0.83
All-cancers	Segovia-Siapco (2018)	Regular meat eaters: HR= 1 Low meat eaters: HR= 0.98 Fish eaters: HR= 0.83 Vegetarians/Vegans: HR= 0.91
T2D	Papier et al (2019)	Regular meat eaters: HR= 1 Low meat eaters: HR= 0.63 Fish eaters: HR= 0.47 Vegetarians/Vegans: HR= 0.63

Table A-6: Selection of health impacts included in the valuation							
Health effect	Relevant studies	Evidence basis	Negative correlation (more fish, less effect)		Positive correlation		Selected?
			Reg-Low Meat	Veg-Fish Eaters	Reg-Low Meat	Veg-Fish Eaters	
Colorectal	Appleby et al. 2016	UK EPIC	Yes, stat. significant	Yes, stat. significant			Yes
	Jedrychowski 2008	Hospital-based Cohort in Poland	Fish consumption quartiles: yes, statistically significant				
	Key et al. 2014	UK EPIC		Yes, stat. significant			
	Segovia-Siapco (2018)	UK EPIC		Yes, stat. significant			
	Rada Fernandez de Jauregui (2018)	UKWCS (UK women's cohort)	Yes, red meat vs poultry eaters[38]	Yes, for veg-fish			
Prostate	Key et al. 2014	UK EPIC		Yes, stat. significant			No
	Segovia-Siapco (2018)	UK EPIC		Yes (but limited), stat significant			
Breast	Cade et al (2010)	UKWCs (UK women's cohort)	Yes, red meat vs poultry eaters[39]	Yes, for veg-fish			No
	Appleby et al. 2016	UK EPIC	Yes, stat. significant			Yes, stat. significant	
	Segovia-Siapco (2018)	UK EPIC				Yes, stat. significant	
	Key et al. 2014	UK EPIC				Yes, stat. significant	
Lung	Appleby et al. 2016	UK EPIC	Yes, stat. significant	Yes, stat. significant			Yes
	Key et al. 2014	UK EPIC		Yes, stat. significant			
Ovary	Appleby et al. 2016	UK EPIC	Yes, stat. significant	Yes, stat. significant			Yes
	Key et al. 2014	UK EPIC		Yes, stat. significant			
Kidney	Key et al. 2014	UK EPIC		Yes, stat. significant			No
Endometrial	Key et al. 2014	UK EPIC		Yes, stat. significant			No
Hepatocellular carcinoma	Ferdiko 2013	European EPIC (large scale)	Fish consumption quartiles: yes, statistically significant				No

[38] Poultry eaters eat more fish and less red meat.
[39] Poultry eaters eat more fish and less red meat.

Table A-6: Selection of health impacts included in the valuation

Health effect	Relevant studies	Evidence basis	Negative correlation (more fish, less effect)		Positive correlation		Selected?
			Reg-Low Meat	Veg-Fish Eaters	Reg-Low Meat	Veg-Fish Eaters	
CHD mortality	Zheng et al (2011)	Meta analysis (Europe, Finland, Netherlands)	Yes, 1 serving vs 2-4 servings				No
Diabetes	Papier et al (2019)	UK EPIC	Yes, stat. significant	Yes, stat. significant			Yes
	Patel et al	European EPIC	Fish consumption quartiles: yes, statistically significant but only between 1st and 2nd quartile				
	Segovia-Siapco (2018)	UK EPIC	Meat vs semi-vegetarian, yes			Vegans, lacto-ovo vegetarians better off than pesco-vegetarians	
Heart failure	Li Yue-hua	Meta analysis: NL, SE, US	Yes, based on portions				No
Mental and behavioral disorders Diseases of the respiratory system Diseases of the digestive system	Appleby et al. 2016	UK EPIC	Yes, stat. significant	Yes, stat. significant			No (because we would not be able to monetise)
All cancers	Segovia-Siapco (2018)	UK EPIC		Yes, stat. significant			Yes
	Appleby et al. 2016	UK EPIC	Yes, not stat. significant	Yes, not stat. significant			
	Key et al. 2014	UK EPIC		Yes, not stat. significant			

A1.2.5 Health outcomes where evidence is less robust

Breast cancer

There are over 40,000 women diagnosed with breast cancer every year and a forecast for 2040 is of 57,000 cases diagnosed.

Very limited information has been found on the link between diets and breast cancer although it is acknowledged that the risk of breast cancer is higher in women who are overweight, particularly after the menopause. This is because being overweight may change hormone levels in the body (MacMillan, 2019)[40].

Only one study has been found to be of value. Cade et al. (2010)[41] studies the link between eating fish and reduced risk of breast cancer in a group of women in the UK. More than 33,000 women participated in this study, grouped as follows:

- 65% of them classified as regular meat eaters
- 3% as poultry eaters
- 13% as fish eaters and
- 19% as vegetarians.

The study examines the incidence of breast cancer and risk for women in each dietary group. The study revealed that the overall risk of developing breast cancer is reduced with an increase of 50gr. of fish per day by around 6% across all dietary groups.

Hepatocellular carcinoma (HCC)

Hepatocellular carcinoma (HCC) is cancer of the liver. There were 4,600 cases in England in 2013 and the rate of increase is 8% each year. The forecast for 2040 gives an estimate of 11,000 cases of HCC.

The exact cause of liver cancer is unknown, but most cases are associated with damage and scarring of the liver known as cirrhosis. Cirrhosis can have a number of different causes, not just limited to alcohol. It's also believed obesity and an unhealthy diet can increase the risk of liver cancer because they can lead to non-alcoholic fatty liver disease (NHS, 2019[42]).

Only one robust study has been found during the literature review discussing the relationship between fish consumption and the risk of developing liver cancer. Fedirko et al (2013)[43] studied 520,000 men and women in 10 European countries. The results suggest an inverse relationship between fish intake and the risk of HCC. HCC risk decreased with each 20g increase in total fish offset by the same amount in red meat. Those who consume one portion of fish per week will have a 14% smaller probability to develop liver cancer relative to those who do not eat fish at all. The probability of developing liver cancer when moving from one portion of fish to two a week was found to decrease by 22%.

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[40] https://www.macmillan.org.uk/cancer-information-and-support/breast-cancer/risk-factors-for-breast-cancer

[41] Cade, J.E., Taylor, E.F., Burley, V.J. and Greenwood, D.C., (2010). Common dietary patterns and risk of breast cancer: analysis from the United Kingdom Women's Cohort Study. Nutrition and cancer, 62(3), pp.300-306.

[42] https://www.nhs.uk/conditions/liver-cancer/

[43] Fedirko, V., A. Trichopolou, C. Bamia, T. Duarte-Salles, E. Trepo, K. Aleksandrova, U. Nöthlings, et al. 2013. “Consumption of Fish and Meats and Risk of Hepatocellular Carcinoma: The European Prospective Investigation into Cancer and Nutrition (EPIC).” Annals of Oncology 24 (8): 2166–73. https://doi.org/10.1093/annonc/mdt168.

Endometrial cancer

Womb cancer is the 4th most common cancer in women in the UK with around 9,300 cases per year from 2014 to 2016 in the UK (Cancer Research, nd[44]). Figures for England have however not been found.

Being overweight or obese is the biggest preventable risk factor of womb cancer. A Cancer Research UK study published in 2011 found that being overweight or obese causes around a third of womb cancers in the UK each year.

Only one robust study has been identified during the literature review discussing the relationship between fish consumption and the risk to develop endometrial cancer. Key et al. (2014) found that fish eaters have a 18% smaller risk of developing womb cancer relative to a regular meat eaters. Relative to vegetarians and vegans, fish eaters have a 17% smaller probability to develop endometrial cancer.

Prostate cancer

There were around 41,000 prostate cancer cases in 2013 in England and is the most common cancer in men.

The review of the literature identified two robust studies, analysing the relationship between fish consumption and the reduction in risk of developing prostate cancer, with similar conclusions.

- Key et al. (2014) concluded that fish eaters have a smaller risk to develop prostate cancer compared to meat eaters and vegetarians and vegans (26% and 11% respectively)
- Segovia-Siapco et al (2018) concluded that it is 11% less likely for fish eaters to develop prostate cancer, relative to low meat eaters.

Obesity and diet can have an impact on the risk of prostate cancer, although it is not considered the main risk factor (age and family history are two of the main).

Kidney cancer

Each year over 12500 people in the UK are diagnosed with kidney cancer. Estimates for England in 2013 are of 8,500 cases diagnosed each year, but the trend is of a 6% increase.

Obesity is one of the risk factors, according to the NHS.

Only one study has been found of statistical relevance, already presented above. Key et al. (2014) estimated the risk to be diagnosed with kidney cancer for fish eaters to be lower than meat eaters and vegetarians and vegans. Fish eaters have a 77% smaller probability relative to a regular meat eater, vegetarians and vegans.

Coronary Heart Disease (CHD)

Coronary heart disease (CHD) is a major cause of death both in the UK and worldwide and the risk can be reduced by health eating (NHS, 2020[45]).

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[44] https://www.cancerresearchuk.org/about-cancer/womb-cancer?gclid=EAIaIQobChMI4tSinuSt5wIVQbTtCh3U9gm2EAAYASAAEgJh_vD_BwE&gclsrc=aw.ds

[45] https://www.nhs.uk/conditions/coronary-heart-disease/

The incidence for CHD in England was 400,400 episodes in 2018 and the forecast for 2040 gives an estimate of 375,000 episodes.

The literature review has identified one statistically significant study but it is not UK based. Zheng et al. (2011) conducted a meta-analysis with 315,812 European and overseas participants over a period of 16 years. In comparison with individuals who do not consume fish at all, those with low fish consumption have a 14% smaller probability of CHD, whilst the risk for those with higher fish consumption (i.e. two servings per week) being 33% smaller than those with zero fish consumption.

Coronary heart disease can also lead to heart failure. There were 188,700 Finished Consultant Episodes (FCE) of heart failure in England, in 2018. FCE is the time a patient spends in the care of one consultant in one health-care provider (f a patient is transferred to a different hospital provider or a different consultant within the same hospital, a new episode begins). Hospital admission accounted for over 86,000.

Only one robust study has been identified in the literature review. LI Yue-hua, (2013) conducted a meta-analysis in US and EU population (Sweden and The Netherlands) and found that individuals who consume one portion of fish per week have a reduction in risk of health failure by 9% relative to those who do not eat fish. Those who consume two portions of fish per week have a 13% smaller probability to be diagnosed with a heart failure episode, compared with those who do not eat fish. Individuals who consume two portions are 4% less likely to have a heart failure episode, in comparison with those who consume one portion per week.

Diseases of the respiratory system

Respiratory disease affects one in five people and is the third biggest cause of death in England (after cancer and cardiovascular disease). In addition to lung cancer, diseases of the respiratory system include: Asthma; Chronic Obstructive Pulmonary Disease (COPD); Chronic Bronchitis; Emphysema; Cystic Fibrosis/Bronchiectasis; Pneumonia and Pleural Effusion.

Hospital admissions for lung disease have risen over the past seven years, at three times the rate of all admissions generally.

Appleby et al. (2016) has also estimated the risk of developing diseases of the respiratory system associated with different diets. The study found that fish eaters have 27% lower risk to develop diseases of the respiratory system compared to regular meat eaters but the difference was smaller with low meat eaters.

Diseases of the digestive system

There are other diseases of the digestive system associated with a poor diet (e.g. bloating, irritable bowel syndrome (IBS), diarrhea, heartburn, reflux, constipation, nausea and others).

Appleby et al. (2016) estimated that on average, fish eaters have 20% lower risk to develop diseases of the digestive system compared to regular meat eaters. When fish eaters are compared with vegetarians (zero fish consumption), it turns out that fish eaters have 5% lower risk to be affected by any disease of the digestive system.

Mental and behavioural disorders

There is increased evidence that diet can have an effect on mental health and behavioural conditions. Similarly, ill-health will affect the mental condition of most patients.

Specific to fish, Appleby et al. (2016) estimated the risk of developing mental and behavioural disorders among regular meat eaters, low meat eaters, fish eaters, vegetarians and vegans. Among 110 deaths of mental and behavioural disorders, 11 of them were those of fish eaters. On average, fish eaters have a 6% lower probability to develop any type of mental and behavioural disorders compared to regular meat eaters, vegetarians and vegans (HR=0.96 for fish eaters). When low meat eaters are compared with regular meat eaters, those individuals in the first group have a 38% lower probability to be diagnosed with mental and behavioural disorders. When low meat eaters are compared with fish eaters, it is 34% less likely for those in the first group to develop any of these disorders.

A1.2.6 Mortality outcomes

It is important to note that some of the health conditions may result in deaths. Mortality has been incorporated in the model by by using estimates of life expectancy from the Office for National Statistics (ONS) life tables and the EQ-5D (utility) population norms calculated by Kind et al. (1999).

Table A-7: Mortality rate (MoR)
EQ-5D is a standardized instrument for measuring generic health status. It has been widely used in population health surveys, clinical studies, economic evaluation and in routine outcome measurement in the delivery of operational healthcare. An EQ-5D health state is the set of responses to the 5 dimensions of EQ-5D, as completed by a patient or respondent. For instance, a fairly healthy person may have an EQ-5D health state of 1-2-1-1-1. When used in economic evaluation EQ-5D preference weights are combined with time to compute quality-adjusted life years (QALY).

The assumptions for Mortality rates used in the model are summarised in the next table.

Table A-8: Mortality rate (MoR)	
Endpoint	**Mortality rate**
All cancers	47% (Cancer Research notes 50% survival rate)
Colorectal cancer	Approximately 44%, with a 10% contribution to total cancer deaths. There has been a significant reduction in mortality rates since the early 1970
Lung cancer	80% after 5 years. 21% of lung cancer contributes to total cancer deaths in the UK, 2015-2017 data. The peak rate of lung cancer deaths is 85 to 89 years.
Ovarian cancer	No data on contribution to total cancer deaths but 35% of patients survive ovarian cancer for 10 or more years, 2010-11 in England and Wales.
Type 2 Diabetes (T2D)	Mortality linked to complications, e.g. stroke, heart failure, heart attack, etc. Life expectancy reduction of 10 years.
Source: Luengo-Fernandez, R. et al (2013): Economic burden of cancer across the European Union: a population-based cost analysis; Lancet Oncology; 14: 1165–74, published online October 14: http://dx.doi.org/10.1016/S1470-2045(13)70442-X https://www.cancerresearchuk.org/health-professional/cancer-statistics/statistics-by-cancer-type/lung-cancer/mortality https://www.cancerresearchuk.org/health-professional/cancer-statistics/statistics-by-cancer-type/ovarian-cancer g/health-professional/cancer-statistics/statistics-by-cancer-type/bowel-cancer/mortality	

A1.3 Literature review on economic values

A1.3.1 Overview of approaches to value the socio-economic impacts

There are different approaches to value health benefits. Often, health impacts are valued following a Cost of Illness (COI) Approach. This approach is market-based and consists of monetising the healthcare costs, including the hospital admissions and also the costs of care for the patients. Such costs are expected to accrue to the NHS. The National Institute for Health and Care Excellence (NICE) has developed a wealth of evidence on the COI of different morbidity conditions[46].

COI studies often include the "indirect" costs of lost production resulting from disease. In most COI studies, productivity costs are estimated primarily as the economic value of production foregone associated with loss of paid employment (foregone gross earnings). These will accrue to employers and patients (depending on the statutory paid arrangements).

COI approaches fail however to capture the non-financial aspects, or social cost, of being in ill-health to individuals. Other metrics have been developed to account for the intangibles, or loss of utility, to individuals experienced from a reduction in their quality of life as a result of not being in perfect health. These non-market approaches are based on patient-based outcome measures, which are more closely related to patients' perceptions of illness. The quality-adjusted life year (QALY) is a generic measure of disease burden, including both the quality and the quantity of life lived. It is used in economic evaluation to assess the value of medical interventions. One QALY equates to one year in perfect health. QALY scores range from 1 (perfect health) to 0 (dead). QALYs are also developed for different health conditions by NICE and currently a threshold applies in order to justify interventions. NICE's 'threshold', for which treatments are less likely to be recommended for use in the NHS, is typically between £20,000 and £30,000 per QALY[47]. Although there has been and continues to be discussion to change this threshold, for specific interventions, new promising technologies and to raise it for rare conditions[48], this study will use the £20,000 per QALY in line with current practices.

A framework describing the different cost components by cost bearer is shown in Table A-9, building on the cost framework developed by the UK Health and Safety Executive for their recent work on the Costs to Britain of Work-Related Cancer (2016)[49]. The reduction of costs should be interpreted as benefits from changes in diet.

Table A-9: Framework for estimating the benefits from increasing fish consumption

Type of benefits	Consumer/worker	Employer	Government/NHS
Direct	Avoiding out of pocket expenses Avoiding premiums for private medical insurance	Avoiding corporate private health insurance premiums	Avoiding medical treatment and rehabilitation costs/healthcare costs

[46] https://www.evidence.nhs.uk/search?q=cost+of+illness

[47] https://www.nice.org.uk/glossary?letter=q

[48] Consultation and recommendation available at: https://www.nice.org.uk/about/what-we-do/our-programmes/nice-guidance/nice-technology-appraisal-guidance/consultation-on-changes-to-technology-appraisals-and-highly-specialised-technologies and https://www.kingsfund.org.uk/publications/articles/ministers-not-nhs-england-should-decide-affordability-of-treatments

[49] UK HSE (2016): Costs to Britain of Work Related Cancer, Research Report 1074, available at: http://www.hse.gov.uk/research/rrhtm/rr1074.htm

Indirect	Avoiding loss of earnings due to absence from work (both short term absence whilst undergoing treatment but also absence in the future, e.g. due to reduced working hours or permanent withdrawal from work. Avoiding loss of state pension income Avoiding informal care costs, reflecting the opportunity cost of unpaid care	Avoiding loss of output due to workplace absence, worker's productivity loss, together with costs from loss of experience/expertise and costs of overtime working, etc. Avoiding recruitment and induction costs. The employer may recruit temporary or permanent replacement staff and supply them with suitable induction support. Avoiding payments related to sick leave Avoiding work reorganisation	Avoiding state payments Avoiding state benefit payment Avoiding loss of tax and national insurance receipts
Intangible	A monetary value of the impact on quality of life	-	-

The types of avoided costs estimated in this study are set out in Table A-10. The next sections describe the different costs assumptions used in the model.

Table A-10: Benefits framework

Category	Cost	Bearer	Notes
Direct	Healthcare (Ch)	Government	Cost of medical treatment, including hospitalisation, surgery, consultations, radiation therapy, chemotherapy/immunotherapy, etc.
	Informal care[50] (Ci)	Family of the patient	Opportunity cost of unpaid care (i.e. the monetary value of the working and/or leisure time that relatives or friends provide to those with cancer)
	Cost for employers (Ce)	Employers	Cost to employers due to absence from work, insurance payments, recruitment, work reorganisation, etc.
Indirect	Mortality – productivity loss/costs (Cp-mort)	Employer/patient	The economic loss due to premature death
	Morbidity – lost working days (Cp-morb)	Employer/patient	Loss of earnings and output due to absence from work due to illness or treatment
Intangible	QALYs lost (Cqaly)	Patient	Willingness to pay to avoid death or reduced quality of life

[50] A decision has been taken to include informal care costs in this analysis even though some elements of these costs may also have been included in individuals' willingness to pay values to avoid a future case of ill health. This decision may result in an overestimate of the benefits as generated by this study.

If all of the cost categories in the table above were summed up, there would be some double counting, for example healthcare is partly financed by employers' insurance contributions.. The way these costs have been summed up is summarised below.

$$Total\ cost = Ch\ (healthcare) + Ci\ (informal\ care) + Cp - mort\ (productivity\ loss\ from\ mortality + Cp - morb\ (productivity\ loss\ from\ morbidity) + Cqaly\ (intangible\ cost)$$

In the case of cancer, *Ce* (cost for employers) is not considered in the totals to avoid double-counting and separate estimates based on the cost to employers per case of cancer reported in the literature are used to estimate the overall cost to employers. For T2D, it is assumed that the employer incurs a proportion of the productivity loss – this is divided between the government (20%), the individual (30%) and the employer (50%).

In terms of assigning the benefits to the different stakeholder groups, the table below provides an overview of who bears the costs quantified in this study.

Table A-11: Costs by stakeholder group

Stakeholder group	Costs	Method of summation
Workers/family	*Ci, Cp-mort,Cp-morb, Cqaly*	*CtotalWorker&Family=Ci+0.8*(Cp-mort+Cp-morb)+Cqaly*
Governments	*Ch*, part of *Cp-mort and Cp-morb* (loss of tax revenue)	*CtotalGov=Ch+0.2*(Cp-mort+Cp-morb)*[51]
Employers	*Ce*	*CtotalEmployer=Ce*

There will be also costs to consumers from switching diets to more expensive food. The costs to the consumers have been monetised using information from UK sources of data. Current UK consumption and expenditure are available from existing YouGov surveys and consumer surveys such as the Family Food Survey[1]. These have been used to calculate the costs to the consumers from replacing meat products with fish products.

For the monetisation of health outcomes, the UK-based research was supplemented by non-UK data sources.

A1.3.2 Modelling socio-economic impacts

To account for the health gains experienced, while remaining within the limits of time and clarity, the impacts of four major diseases were modelled which have been shown to improve with increased consumption of fish, as described in section 3, namely:

- Colorectal cancer;
- Lung cancer;
- Ovarian cancer; and
- Type 2 Diabetes.

An aggregate for all cancers has also been used. All cancer types' are included as a separate category and this includes different cancer codes (C00-C97). Segovia-Siapco et al (2018) estimated that the risk of developing cancer (all types) was 11% smaller for fish eaters than meat eaters. This has been used

[51] Assumes 20% tax. This is based on previous studies carried out by RPA, for example: https://ec.europa.eu/social/main.jsp?catId=738&langId=en&pubId=8224&furtherPubs=yes

to validate the total costs to findings on the individual types of cancer but also to account for the interlinkages between the different health outcomes.

Modelling was possible for specific cancer types where evidence was more robust (lung, ovarian and colorectal). Other modelling for other cancer types could not be undertaken due to scarcity of more robust data. Although unit costs are also available for some of the other effects such as heart failure, coronary heart disease and kidney damage, they have not been monetised due to the potential overlap with T2D.[52]

The model includes the comparison of two cohorts, one at the current level of consumption and another at increased seafood consumption to the recommended amounts of 280 grams per week. The perspective is a societal one, taking into account impacts on public expenditure (including the NHS), the wider economy (i.e. productivity gains/losses) and the increased quality of life of the people that would have otherwise developed the five conditions. The model considers the avoided incidence in a single year but takes a lifetime perspective to the valuation of its effects in order to capture all the relevant benefits.

To establish the baseline, incidence rates for each of the health outcomes together with hazard ratios for different dietary habits were used to inform the model. To determine how these risks changed as the consumption of fish increased, we used the best available evidence, expressed as hazard ratios, identified in the literature review of outcome data, outlined in Section 3.2. Mortality has also been examined for the different health outcomes. For example, data on cancer mortality have been reported in a number of studies. Fatalities are monetised separately from morbidity outcomes.

Other key features and assumptions of the model are summarised in the Table A-12.

Table A-12: Key assumptions of the model for this research

Factor	Chosen value	Rationale/reference
Cases monetised	Avoided incidence in a single year	Due to uncertainties about the time lag between the start of dietary change and the outcome, a longer time period would not be appropriate
Time horizon	Lifetime	NICE methods manual
Intangible impacts measured in:	QALYs	NICE methods manual Allows impacts over different health effects to be assessed simultaneously
Discount rate	3.5%	NICE methods manual
Perspective	Societal	HM Treasury Green book
Time lag between initiation of dietary change and benefits accrual	10 years	Common timeframe used in epidemiological data

A1.3.3 Cost of healthcare and informal care

Cancer

A range of studies have been identified that provide estimates of the costs of medical treatment for cancer patients (as shown below). Luengo-Fernandez et al (2013) also provide average unit costs (in

[52] https://www.diabetes.org.uk/resources-s3/2019-02/1362B_Facts%20and%20stats%20Update%20Jan%202019_LOW%20RES_EXTERNAL.pdf

2009 prices) for the health care costs associated with GP visits, outpatient visits, A&E visits and inpatient days for 27 of the 28 EU MS (data are not included for Croatia). These are summarised below by cancer site.

Table A-13: **Estimates of the annual cost per patient of cancer**			
Cancer	**Health care**	**Informal care**	**Total annual cost**
Ovarian	£5,079*	£2,313*	£7,392*
Lung	£5,840	£5,274	£11,113
Colorectal	£4,231	£2,156	£6,387
All cancers	£5,079	£2,313	£7,392

Note:
*No site specific data available – average values across all cancers used.
Sources:
Cancer Research UK (not dated): Ovarian cancer survival statistics, available at https://www.cancerresearchuk.org/health-professional/cancer-statistics/statistics-by-cancer-type/ovarian-cancer/survival#heading-Zero
Luengo-Fernandez, R. et al (2013): Economic burden of cancer across the European Union: a population-based cost analysis; Lancet Oncology; 14: 1165–74, published online October 14: http://dx.doi.org/10.1016/S1470-2045(13)70442-X

The cost figures presented in the above tables correlate well with the average per case lifetime treatment cost estimated in the UK HSE study of £8,200, which is considered to reflect the top 90% of occupational cancers. Note that the average medical costs shown in the table below are annual figures and apply to patients over the period of time that they continue to be treated.

Note that these costs are assumed to apply to all cancer registrations in the analysis presented here, regardless of whether or not the cancer is fatal or non-fatal.

Type 2 diabetes

We have sought estimates of annual national-level expenditure for each health outcome and divided this by the estimates of the prevalent population to generate yearly costs for a hypothetical average patient. An example of annual direct health costs for two of the five health outcomes identified during the literature review and the data sources used to calculate them are given in Table 4-4. These costs include NHS and social care costs and have been inflated to 2017/18 prices (with lack of 2018/19 indices) using the PSSRU hospital and community health services (H&CHS) indices (Curtis and Burns, 2018). Type 2 diabetes treatment accounts for just under 9% of the annual NHS budget. This is around £8.8 billion a year[53]. The average per case lifetime treatment cost estimated in the UK HSE study of £8,200, which is considered to reflect the top 90% of occupational cancers.

Table A-14: **Example of annual direct health outcome costs per person for T2D for the NHS**			
Health outcome	**Year and population**	**Cost per patient***	**Source**
Type 2 diabetes - direct healthcare costs[1]	2010/11 UK	£2,825	National expenditure from Hex et al. (2012) Prevalence from Hex et al. (2012) Inflation from Curtis and Burns (2018) PSSRU

* Cost inflated to 2017/18
[1]Direct costs were estimated from data on diagnosis, lifestyle interventions, ongoing treatment and management, and complications.

[53] NHS (2019): https://www.england.nhs.uk/diabetes/diabetes-prevention/

Table A-14: **Example of annual direct health outcome costs per person for T2D for the NHS**			
Health outcome	**Year and population**	**Cost per patient***	**Source**
[2]Includes primary care, outpatient care, A&E, inpatient care, medications. **Full source:** Hex, N. et al. (2012) 'Estimating the current and future costs of Type 1 and Type 2 diabetes in the UK, including direct health costs and indirect societal and productivity costs', Diabetic Medicine. John Wiley & Sons, Ltd (10.1111), 29(7), pp. 855–862. doi: 10.1111/j.1464-5491.2012.03698.x. Curtis, L. A. and Burns, A. 2018. 'Unit costs of health and social care 2018'. doi: 10.22024/UniKent/01.02.70995. Derived from NHS Reference costs and PSSRU.			

Langa et al (2002)[54] report additional annual cost of informal care for diabetes[55] patients of '$1,000 for those taking no medication, $800 for those using oral medications, and $1,700 for those using insulin'. An average of these values has been updated to 2019 prices and converted into GBP, thus suggesting an annual cost of informal care of £1,400.

Summary of healthcare and informal care costs

The treatment periods used in the model are given below. These determine the period of time over which treatment is provided and the sufferer experiences disutility. The end of the treatment period signifies either a fatal or illness-free outcome.

Table A-15: **Treatment period/average disease duration**	
Health outcome	**Treatment period (years)**
Cancer	5
Type 2 diabetes	30
Sources: Cancer - RPA (2018): Third study on occupational exposure limits – methodological note, available at https://ec.europa.eu/social/main.jsp?catId=738&langId=en&pubId=8224&furtherPubs=yes Type 2 diabetes - T2D is typically diagnosed at ages over 40 and shortens life expectancy by about 10 years, therefore assumed that the maximum length of time over which people live with T2D is around 30 years. Sources: https://www.diabetes.org.uk/resources-s3/2017-11/diabetes_in_the_uk_2010.pdf and https://www.diabetes.co.uk/diabetes-life-expectancy.html	

The annual healthcare and informal care costs of the effects considered in this study are summarised in Table A-16.

Table A-16: **Summary of the annual healthcare and informal care costs per patient (in 2019 prices where available)**			
Effect	**Health care**	**Informal care**	**Total cost per case**
All cancers	£5,800	£2,700	£8,500
Ovarian	£5,800	£2,700	£8,500
Lung	£6,700	£6,000	£12,700
Colorectal	£4,800	£2,500	£10,000
T2D	£2,825	£1,400	£4,225
Sources:			

54 Langa K. M. et al (2002): Informal Caregiving for Diabetes and Diabetic Complications Among Elderly Americans, available at https://academic.oup.com/psychsocgerontology/article/57/3/S177/581331

55 Any diabetes, not only T2D.

Table A-16: **Summary of the annual healthcare and informal care costs per patient (in 2019 prices where available)**			
Effect	**Health care**	**Informal care**	**Total cost per case**
Langa K. M. et al (2002): Informal Caregiving for Diabetes and Diabetic Complications Among Elderly Americans, available at https://academic.oup.com/psychsocgerontology/article/57/3/S177/581331 Luengo-Fernandez, R. et al (2013): Economic burden of cancer across the European Union: a population-based cost analysis; Lancet Oncology; 14: 1165–74, http://dx.doi.org/10.1016/S1470-2045(13)70442-X			

Productivity losses

Individuals will incur costs associated with their inability to work in terms of a loss of earnings, including losses linked to days of for treatment as well as days off due to illness. Luengo-Fernandez et al (2013) developed an estimate of the magnitude of such costs by EU Member State in terms of an average cost per fatal or non-fatal cancer. These included what are referred to as "productivity losses" due to early death and then lost working days due to morbidity effects.

Table A-17: **Estimates of the cost per patient over treatment period**		
Effect	**Productivity losses**	**Lost working days**
Cancer (any)	£4,000 per case	£1,000 per case
Type 2 diabetes	Absenteeism: £5,500 per year	
Sources: Kanavos et al (2012): Diabetes expenditure, burden of disease and management in 5 EU countries, LSE 2012 Luengo-Fernandez, R. et al (2013): Economic burden of cancer across the European Union: a population-based cost analysis; Lancet Oncology; 14: 1165–74, published online October 14: http://dx.doi.org/10.1016/S1470-2045(13)70442-X		

Improved quality of life for the consumer

There will be also costs related to the emotional pain of being in a specific health condition. The QALY method values the physical and emotional harm of the disease. The measures are used by the National Institute of for Health and Care Excellence (NICE). A QALY is constructed based on two components: the length of time (over which QALYs are calculated) and the associated HRQoL. The length of time is the clinical hard outcome (e.g. remaining life expectancy or life-years gained). The more difficult data for QALY estimation are the values (often referred to as utilities, preferences or weights) to quality adjust the length of time.

In order to estimate the effect of developing a comorbidity on health-related quality of life, we undertook searches to identify estimates of the utility values associated with each of the conditions contained in the model. These utility values, and their source, are reported in the table below. From these we can calculate the disutility (the utility loss associated with living with the condition for one year), by subtracting the disease-specific utility from that of the general population. Utility scores for the general population in the UK are taken from a paper by Kind et al. (1999), which presents results from a nationally representative interview of survey 3395 men and women aged 18 or over living in the UK. Amongst other things the survey collected information on health status using the EQ-5D, which is used to evaluate health-related quality of life (HRQoL) of individuals. These data can be used as baseline values for comparative purposes in this study.

In order to calculate the disutility as a result of a particular health condition (e.g. Type 2 diabetes and stroke), the disease-specific utility values, taken from the literature, are subtracted from that of the general population. The results are presented in Table A-18.

Table A-18: **Utility and disutility values for different health effects**			
Health effect	**Utility**	**Disutility**	**Source**
Type 2 diabetes – general population	0.67	0.13	Janssen et al. (2011)
Type 2 diabetes – diabetic retinopathy	0.57	0.23	Janssen et al. (2011)
Colorectal cancer	0.617	0.183	Huang et al. (2018)
Cancer default value	-	0.2	Average of colorectal and breast cancer in Huang et al (2018) and Hall et al (2015)

Janssen, M. F. et al. (2011) 'The use of the EQ-5D preference-based health status measure in adults with Type 2 diabetes mellitus', Diabetic Medicine, 28(4), pp. 395–413. doi: 10.1111/j.1464-5491.2010.03136.x.

Huang, W. *et al.* (2018) 'Assessing health-related quality of life of patients with colorectal cancer using EQ-5D-5L: a cross-sectional study in Heilongjiang of China', *BMJ Open*, 8, p. 22711. doi: 10.1136/bmjopen-2018-022711.

Hall, P. S. et al. (2015) 'Costs of cancer care for use in economic evaluation: a UK analysis of patient-level routine health system data', British Journal Of Cancer. The Author(s), 112, p. 948. Available at: https://doi.org/10.1038/bjc.2014.644.

Janssen, M.F., Bonsel, G.J. and Luo, N., (2018). Is EQ-5D-5L better than EQ-5D-3L? A head-to-head comparison of descriptive systems and value sets from seven countries. Pharmacoeconomics, 36(6), pp.675-697

For this study the NICE threshold of £20,000[56] is used to put a value on the loss of welfare to patients from not being in good health.

In order to account for the increasing age of the population over time, based on the results of the study by Kind et al. (1998), a utility decrement of 0.004 was applied during each year of the model.

Benefits to employers

Employers will also reap benefits from their employees having a lower risk of illness. Such benefits include:

- higher labour productivity resulting from reductions in absenteeism and associated production losses;
- reduced administrative or legal costs relating to employees who are ill; and
- reduced sick leave payments.

A study commissioned by DG Employment (2011)[57] considers the socio-economic costs of accidents and ill-health relating to work and the benefits to employers of implementing effective health and safety management policies. The report estimates that the cost to employers for a single case of a high-severity accident or disease is £9,911). This figure is based on data pertaining to cost categories such as:

- reduced productivity of the injured employee after re-employment;
- costs of a replacement (difference in salary, reduced productivity);
- overtime of colleagues to compensate;

[56] McCabe C et al (2008): The NICE costs-effectiveness threshold: what ti is and what that means, Pharmacoeconomics. 2008;26(9):733-44, available at: https://www.ncbi.nlm.nih.gov/pubmed/18767894
[57] See http://ec.europa.eu/social/BlobServlet?docId=7416&langId=en

- rehabilitation costs (those paid by employer);
- medical costs (those paid by employer);
- administrative follow-up;
- reorganising the work; and
- training the replacement (time of the trainer).

The study collected data on these cost categories as well as compiling information about 400 cases of worker accidents and ill health. These cases were from 13 sectors including construction, transport and the chemical sector, though the numbers of cases linked to the latter were limited and this should be considered when applying this estimate to the benefits.

Another reason for caution in interpreting this result is that the study only considered a small sub-set of health endpoints so the estimated costs may be too generic and therefore, are likely to underestimate the costs to the employer of occupational cancer.

HSE (2016) was able to develop estimates of the costs borne by employers, sickness costs.[58] For the UK, they estimated that around 3% of total costs to society were borne by employers, with this equating to a cost of roughly £14 (€17) per worker per annum. Multiplying it across the EU-28 worker population (aged 15 to 64) gives a total figure of £3.5 billion in costs to employers associated with the costs of production disturbance, sickness payments due to worker absence and legal obligations with regard to employers' liability insurance. This figure does of course reflect requirements in the UK which may be more or less onerous than those that apply in other Member States. However, it provides an indication of significance of these costs.

Many cancers have latency periods of between 10 and 50 years. As a result, most individuals diagnosed with occupational exposure-related cancer (estimated at over 70%) will have left work by the time they are diagnosed, or may have changed jobs. The relevant employer during the period of exposure is therefore unlikely to bear the costs of disruption from sickness absence, paying sick pay etc. As noted by the UK HSE, this estimate is also an underestimate as it fails to capture some costs to employers that may be significant, such as those associated with the loss of expertise and organisational knowledge, and reductions in productivity of those returning to work after successful cancer treatment. Reputational damage (which can impact on sales and recruitment) is also not included.

Mortality

Mortality rate as a result of the relevant condition is important since different monetary values are associated with mortality and morbidity.

[58] UK HSE (2016): Costs to Britain of Work Related Cancer, Research Report 1074, available at: http://www.hse.gov.uk/research/rrhtm/rr1074.htm

Table A-19: **Mortality**	
Endpoint	**Mortality rate after 5 years**[59]
Colorectal cancer	44%
Lung cancer	80%
Ovarian cancer	54%
Average of all cancers	47%
T2D	Mortality linked to complications, e.g. stroke, heart failure, heart attack, etc. Life expectancy reduction of 10 years
Sources: Diabetes UK (non-dated): Diabetes Life Expectancy, available at https://www.diabetes.co.uk/diabetes-life-expectancy.html Luengo-Fernandez, R. et al (2013): Economic burden of cancer across the European Union: a population-based cost analysis; Lancet Oncology; 14: 1165–74, published online October 14: http://dx.doi.org/10.1016/S1470-2045(13)70442-X	

6.1 Caveats and issues with interpretation

The above figures are only to be interpreted as an order of magnitude and not all evidence is found to be robust and conclusive. This is particularly relevant for specific health outcomes where some more evidence should be gathered. The reasons could be attributable to the definition of the dietary groups. The figures above are to be read as an order of magnitude of the different economic impacts, and benefits, from increased fish consumption to the recommended amounts with the following caveats:

- Studies identified through the literature review, assess the health benefits from increased fish consumption, typically, estimate the HRs for the different dietary groups. However, these studies are not sufficient to assess the benefits of increased fish consumption across a range of effects. Consequently, for a number of effects this study relies on approximation on the basis of comparisons of the following dietary groups:
    - Vegetarians (in some studies, vegetarians and vegans) vs Fish eaters: although the key difference between these groups is the level of fish consumption, it is unclear whether the different health outcomes can be fully explained by fish consumption alone and can thus be taken as representative of the effects of an increase in fish consumption across all dietary groups, as used in this study. It is also possible that the differences between these groups may arise due to specificities of the vegetarian/vegan diet (e.g. vitamin supplements).
    - Regular meat eaters vs Low meat eaters: It is assumed that, should a regular meat eater reduce their meat consumption and move into the low meat eater category, they would replace some of their meat consumption with fish. Increased fish consumption is thus expected to correlate with decreased meat consumption. It is recognised that this is an uncertain assumption (e.g. data in the EPIC UK cohort shows that regular and low meat eaters have very similar levels of fish consumption[60]).

[59] A mortality rate is the number of deaths during a particular period of time among a particular type or group of people suffering from the condition.

[60] In fact, on average, a low meat eater (as defined in the EPIC cohort) consumes slightly less fish than a regular meat eater.

- The approach to the literature review in this study entails some positive bias in selecting studies that have identified a positive effect of fish consumption on health for modelling in this study.

- It is unclear how long it would take for the benefits estimated in this study to materialise. Epidemiological data spans from 5 to 15 years and for the purpose of modelling in this study, it has been assumed that these benefits would materialise in full ten years after dietary change.

- Data on fish consumption and health outcomes in the relevant studies have been extrapolated to one vs two portions based on the assumption that the relationship between fish consumption and health improvements is linear (e.g. assuming then doubling the consumption level will double the impacts).

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