

<b>Institution:</b> University of Aberdeen		
<b>Unit of Assessment:</b> UoA1: Clinical Medicine		
<b>Title of case study:</b> An appetite for health - research transforming the food we eat		
<b>Period when the underpinning research was undertaken:</b> 2008-2020		
<b>Details of staff conducting the underpinning research from the submitting unit:</b>		
<b>Name(s):</b>	<b>Role(s) (e.g. job title):</b>	<b>Period(s) employed by submitting HEI:</b>
Alexandra Johnstone	Professor of Human Nutrition	2008-present
Gerald Lobley	Research Fellow	1972 - 2011
Wendy Russell	Professor of Human Nutrition	2008 - present
Silvia Gratz	Research Fellow, Gut Health	2008 - present
Sylvia Duncan	Snr Research Fellow, Gut Health	2008 - present
Robert Wallace	Professor (Emeritus)	1976 - 2016 (2016 – present)
Garry Duthie	Professor (Emeritus)	1984 – 2016 (2016 – present)
Harry Flint	Professor (Emeritus)	1985 – 2017 (2018 – present)
Madalina Neacsu	Research Fellow, Human Nutrition	2012 - present
Daniel Crabtree	Research Fellow	2012 - 2015
<b>Period when the claimed impact occurred:</b> 2013 and onwards		
<b>Is this case study continued from a case study submitted in 2014?</b> No		
<b>1. Summary of the impact</b> (indicative maximum 100 words)		
<p>The UK is in the midst of an obesity epidemic, arising from low activity and easy availability of energy-rich foods. Research conducted by the University of Aberdeen's Rowett Institute has identified the nutritional effects of protein, including sustainable plant-proteins, on satiety (repleteness), demonstrating that dietary protein is an effective way to control appetite and slow muscle decline. This research has underpinned collaborations with major commercial food brands - Marks &amp; Spencer (M&amp;S), Tate &amp; Lyle, the Jamie Oliver Group – supporting the development of healthier food options, including with M&amp;S <i>Balanced For You</i> range, worth GBP40 million annually. Therefore, economic impact and enhanced understanding of the health benefits of improved protein consumption in the food sector has been achieved.</p>		
<b>2. Underpinning research</b> (indicative maximum 500 words)		
<p>Research led by Professor Alexandra Johnstone, Rowett Institute at the University of Aberdeen, has been fundamental in understanding the role of dietary protein to control hunger for achieving weight loss. Further research has investigated the role of dietary protein for healthy ageing.</p> <p>Diet trials in men with obesity, consuming high protein-low carbohydrate (HPLC) diet compared to high protein-moderate carbohydrate (HPMC) diet, found that weight loss and reduced hunger were achieved, even with HPMC [R1]. Health benefits of the more balanced HPMC over HPLC were further demonstrated by faecal analysis measuring gut health markers. Following the HPMC diet, cancer-protective metabolites were elevated while hazardous metabolites were present in lower concentration, compared to the HPLC diet [R2]. Combined, these studies demonstrated that the high-protein component of the diet, rather than a low-carbohydrate component, is important in controlling the feeling of fullness (satiety) and highlighted the importance of moderate carbohydrates for gut health. These findings underpinned a contract and consultancy partnership with M&amp;S, who launched their '<i>Fuller Longer</i>' range (now '<i>Balanced For You</i>'), the subject of an impact case study presented for REF2014 entitled "Commercial health food for sustained appetite control" [P1].</p> <p>The research team has since gone on to show that 'feeling full' from high protein diets (protein satiety) can be achieved from plant-based protein sources just as effectively [R3]. Diet studies compared a plant (soy)-based HPMC diet with a meat-based HPMC diet, with grant funding</p>		

from the ALPRO Foundation [P2]. This work has been further developed to examine a range of plant proteins through commercial contracts with Tate & Lyle, investigating the sustainability & functionality of plant protein ingredients for the food sector [R4; P3].

Building on this research, the team have gone on to work in international multi-partner collaborations exploring the science behind protein satiety to provide a way forward in tackling problems of obesity. The team coordinated a 19-partner European research award to develop an understanding of food-gut-brain mechanisms across the lifespan in the regulation of satiety for health [R5; P4]. Multicentre studies used fMRI to determine brain region activation in response to images of high or low-calorie foods when hungry or satiated to examine the influence of protein on appetite control across the life-course, revealing that age did not influence brain responses in satiety.

Aberdeen was the only Scottish university involved in the UK Research Councils 'Priming Food Partnerships' initiative, Protein4Life project, which brought together 5 universities and 6 food industry partners (Sainsburys, Nestle, Mondelez, Bradgate Bakery, Pladis, Premier Foods) to explore the utility of plant-based sustainable protein to address the emerging problem of sarcopenia – an ageing-related skeletal muscle decline starting from middle-age and accelerating with ageing, affecting the majority of adults. Sarcopenia results in health complications and lost work days, carrying health and financial burdens that are set to rise in a progressively ageing UK population. The work led by Prof Johnstone's team was to identify industry partners' barriers and opportunities for healthy and sustainable plant protein foods and report on optimal sources of protein for future food design, leading to a Research Council White Paper – a framework for action [R6; P5].

### 3. References to the research (indicative maximum of six references)

The quality of the research is deemed to be at least of 2\* quality as corroborated by the following peer-reviewed, international publications (Google Scholar citations; University of Aberdeen **researcher staff in bold**):

[R1] **Johnstone AM**, Horgan, GW, Murison SD, Bremner DM, **Lobley GE** (2008). Effects of a high-protein ketogenic diet on hunger, appetite, and weight loss in obese men feeding ad libitum. *American Journal of Clinical Nutrition*, 87:44-55. DOI:10.1093/ajcn/87.1.44 (429)

[R2] **Russell WR, Gratz SW, Duncan SH, Holtrop G, Ince J, Scobbie L, Duncan G, Johnstone AM, Lobley GE, Wallace RJ, Duthie GG, Flint HJ** (2011). High-protein, reduced-carbohydrate weight-loss diets promote metabolite profiles likely to be detrimental to colonic health. *American Journal of Clinical Nutrition*, 93:1062-72. DOI:10.3945/ajcn.110.002188 (517)

[R3] **Neacsu M**, Fyfe C, Horgan G, **Johnstone AM** (2014). Appetite control and biomarkers of satiety with vegetarian (soy) and meat-based high-protein diets for weight loss in obese men: a randomized crossover trial. *American Journal of Clinical Nutrition*, 100:548-58. DOI: 10.3945/ajcn.113.077503 (69)

[R4] **Lonnie M, Laurie I, Myers M, Horgan G, Russell W, Johnstone AM** (2020). Exploring Health-Promoting Attributes of Plant Proteins as a Functional Ingredient for the Food Sector: A Systematic Review of Human Interventional Studies. *Nutrients* 30;12(8):E2291 DOI:10.3390/nu12082291 (2)

[R5] **Charbonnier L, van Meer F, Johnstone AM, Crabtree D, Buosi W, Manios Y, Androustos O, Giannopoulou A, Vieregger MA, Smeets PAM; Full4Health consortium** (2108). Effects of hunger state on the brain responses to food cues across the life span. *Neuroimage* 171:246-255. DOI:10.1016/j.neuroimage.2018.01.012 (8)

**[R6]** Lonnie M, Hooker E, Brunstrom JM, Corfe BM, Green MA, Watson AW, Williams EA, Stevenson EJ, Penson S, **Johnstone AM** (2018). Protein for Life: Review of Optimal Protein Intake, Sustainable Dietary Sources and the Effect on Appetite in Ageing Adults. *Nutrients* 16;10(3). DOI: 10.3390/nu10030360 **(91)**

#### **Grant awards which have supported this work:**

**[P1]** All awarded to Professor Alex Johnstone from Marks and Spencer in Jan – Dec 2009 Consultancy to develop a health food range, GBP15,000  
2010 Contract research to conduct a 4-week weight loss study to test BFY products, GBP95,000  
2014-2015 Contract research to conduct an 8-week weight loss study to test BFY products-weight loss trial, GBP207,500

**[P2]** Research Grant award to Professor Alex Johnstone as PI from ALPRO Foundation to investigate role of gut hormones and amino acids in appetite control in soya and meat diets. Dec 2009 – Nov 2010; GBP58,026

**[P3]** All awarded to Professor Alex Johnstone as PI from Tate & Lyle  
2018 Tate & Lyle Contract Research award to provide a report on plant proteins as a functional ingredient. GBP14,683  
2018 Tate & Lyle Consultancy to present work to T&L Research Advisory Group meeting GBP1,080  
2019 Tate & Lyle Consultancy to present work to T&L 'lunch and learn' to customer group GBP2,160  
2019 Tate & Lyle Contract Research award to provide a follow-up meta-analysis on evidence on plant proteins as a functional ingredient. GBP66,127

**[P4]** Professor Alex Johnstone as Co-Applicant and Work-package Lead  
2011-2016 Full4Health – Exploring appetite control via the FOOD-GUT-BRAIN axis across the life course (8 to 80 years), European Commission, GBP1.2million (Proportion to A. Johnstone: GBP698,791)

**[P5]** Professor Alex Johnstone as Co-Applicant and Work-package Lead  
2017-2018 BBSRC 'Protein for Life – towards a focused dietary framework for healthy ageing' GBP55,132.

#### **4. Details of the impact** (indicative maximum 750 words)

Research by Prof Johnstone on dietary protein has shown it to be an effective means of managing hunger to achieve weight loss in obese individuals. She has also explored sustainable plant protein sources to promote healthy ageing. Together, these findings support the food industry to develop healthier food ranges, delivering economic impact in the food and drink sector, and enhancing public health and food industry understanding of the health benefits of improved protein consumption.

#### **Supporting the food industry to develop healthier food ranges**

While protein-rich diets have been shown to help achieve appetite control and to support an active lifestyle, the challenge for the food sector has been to develop health food ranges that incorporate a protein-carbohydrate formulation that is palatable, sustainably sourced and appetising, while also being compatible with a balanced (high fibre) diet. The Aberdeen research played a key role in developing high protein with balanced carbohydrate formations for the M&S range – '*Fuller Longer*', with Prof Johnstone as the academic consultant for M&S, described in the REF2014 impact case study, "Commercial health food for sustained appetite control". '*Fuller Longer*' has since changed name to '*Balanced For You*' (BFY) and, 10 years on, testimony from the company confirms that the range continues to help customers to achieve their health goals and to contribute to the M&S Plan A sustainability goals **[S1]**. The popularity

of the brand is further illustrated by promotional media materials that highlight the 'high protein and perfectly portioned carbs' in the BFY range, attracting over 2.8 million views [S2].

Since 2016, BFY has been provided as part of British Airways collaboration to offer M&S food on its short haul flights, recognising that passengers wanted '*choices that reflected what they would normally select when out and about*' [S3]. BFY also features in M&S hospital franchise stores, contributing to their proportion of healthy choices that they must make available, according to the guidelines implemented by the Scottish Government in 2017. These guidelines require that food retailers on NHS grounds must comply with Heath Care Retail Standards as per NHS terms. The implementation was successful with 97% compliance from retailers of food and drinks on Scottish hospital sites [S4].

The research from the Rowett Institute has led to Prof Johnstone being involved in two additional relationships. First, Prof Johnstone provided expert advice on the role of protein in satiety to the Jamie Oliver Group, to inform the preparation of the book '*Everyday Super Food*', published in 2015. Prof Johnstone is acknowledged in the book which was 11<sup>th</sup> bestselling in the UK in 2015, with sales revenue of GBP7.3 million [S5]. Second, a partnership began in 2018 with UK-based Tate & Lyle, who supply ingredients globally to the food and beverage industry. Prof Johnstone has presented elements of the research focusing on plant proteins to the Tate & Lyle Research Advisory Group (Aug 2018), a client group of their international producers (Jan 2019). Vice President of Global Nutrition and Open Innovation at Tate & Lyle has worked with Prof Johnstone as they seek to expand their portfolio of plant proteins to support health and wellness, and Johnstone is now leading a research and development project to assess ingredient formulations of plant proteins, specifically to examine the nutrition and health benefits of selected botanical proteins [S6].

### **Delivering economic impact in the food and drink sector**

The Aberdeen-M&S collaboration led to the creation of a GBP40 million health food range for M&S. '*Balanced for You*' accounts for 44% of total healthy meals sales for M&S, or 14% of overall meals space, and 18% of total sales (pre-COVID) [S1]. The partnership was noted in the Scottish Parliament in 2014 as an example of excellent work in relation to the Food (Scotland) Bill [S7, p75]; and as an exemplar for driving economic impact in the Food and Drink sector, contributing to GBP3.3 million gross value added to Scotland's economy (estimated as GBP11.2 million in UK) in the 2017 BiGGAR economic report for Scottish Government [S8, Case Study 9-1, pp38-39].

### **Enhancing public health and food industry understanding of the health benefits of improved protein consumption**

Drawing upon the research undertaken in the Protein4Life project, Prof Johnstone led a collaborative team to produce a White Paper [S9i], which has been used to inform public health and industry sectors on the opportunities for improving health expectancies in the population through improved protein consumption. Recognising the emerging threat of sarcopenia and associated health problems, this work identified that much of the UK adult population fails to consume adequate protein to maintain muscle strength and function in later life. Loss of muscle strength and function directly impacts the economy in both cost of healthcare and loss of workplace productivity. The white paper was presented to the UK Parliamentary and Scientific Committee in March 2019 to inform a discussion on challenges for a growing and ageing population [S9ii] and is also promoted by British Dietetic Association Work Ready pages on Productive Healthy Ageing [S9iii] The work was also presented at Food Matters Live 2019, with over 8,500 attendees from the ingredients, food production, food service and retail, and nutrition sectors [S9iv]. SEFARI, the Scottish Environment, Food and Agriculture Research Institutes consortium hosts a blog by Prof Johnstone on the white paper, which since June 2020 received 65 views [S9v].

The Rowett Institute's approach to collaboration, led by Prof Johnstone and drawing on Aberdeen's research in protein for satiety and nutrition, and in sustainable plant-based protein, provides a sound basis for the ongoing paradigm shift within the food sector.

**5. Sources to corroborate the impact** (indicative maximum of 10 references)

- S1.** M&S testimonial; M&S webpage citing Aberdeen research.
- S2.** Twitter screenshots.
- S3.** British Airways press release; Telegraph news article.
- S4.** Healthcare Retail Standards: Criteria 2016; Evaluation 2019 (p3 and p87).
- S5.** Jamie Oliver testimonial; Jamie Oliver Everyday Super Food book acknowledgement. Press article, book sales.
- S6.** Tate & Lyle Testimonial.
- S7.** Parliamentary Report Oct 2014 (p75):  
<http://www.parliament.scot/parliamentarybusiness/report.aspx?r=9538&mode=pdf>
- S8.** BiGGAR report, Aug 2017 (case study p38-39) - Economic Impact of the Strategic Research Programme 2011-2016.
- S9.** White Paper
  - i. <https://research.ncl.ac.uk/proteinforlife/outputs/>; <https://ktn-uk.co.uk/news/protein-for-life-a-framework-for-action>
  - ii. [Parliamentary & Scientific Committee](#)
  - iii. [British Dietetics Association Work Ready \(Productive healthy ageing\)](#)
  - iv. [Food Matters Live \(foodmatterslive.com\)](#); [FML 2019 presentation](#); email from FML events coordinator.
  - v. [SEFARI blog](#)