

## Impact case study (REF3)

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| <b>Institution:</b> The University of Nottingham  |   |   |
| <b>Unit of Assessment:</b> UoA24  |   |   |
| <b>Title of case study:</b> Research in human metabolism resulted in changes in public health policy and introduction of the 'Sugar Tax' in the UK  |   |   |
| <b>Period when the underpinning research was undertaken:</b> 2005-2016  |   |   |
| <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>    |
| Ian Macdonald   | Professor of Metabolic Physiology<br>Emeritus Professor | 1977 - August 2020<br><br>August 2020 - present |
| Elizabeth J Simpson   | Senior Research Fellow                                  | 1991 – present                                  |
| Moira A Taylor  | Associate Professor of Human Nutrition                  | 2001 – present                                  |
| <b>Period when the claimed impact occurred:</b> 2013-present  |   |   |
| <b>Is this case study continued from a case study submitted in 2014?</b> No   |   |   |
| <p><b>1. Summary of the impact</b></p> <p>Extensive and pioneering research outputs in the field of human nutrition at the University of Nottingham led to the invitation for Professor Macdonald to join the government's Scientific Advisory Committee for Nutrition (SACN) in 2004. Professor Macdonald acted as Chair of the Carbohydrates Working Group and authored the report '<i>Carbohydrates and Health</i>' published in 2015. The UK Government accepted the report in its entirety, including it in public health policy and ultimately introducing the Sugar Tax in 2018. The new policy and tax have had an impact on the sugary drink industry, with widespread reformulations towards a lower sugar content, and also on consumers, who are opting for zero and low sugar-content drinks. These reformulations and change in consumer behaviour have had a positive health, including demonstrably dental health, impact in England. Tax revenues have been allocated to schools' health programmes, in line with a wider government programme to reduce child obesity in the UK. The introduction of the Sugar Tax attracted wide media attention, which sparked public awareness of the negative impact of sugar on health.</p>  |   |   |
| <p><b>2. Underpinning research</b></p> <p>The UK has one of the highest obesity rates amongst developed countries, with two in three adults identified as obese. Obesity increases an individual's risk of disease and is an economic burden on the tax payer. Professor Macdonald and his team at the University of Nottingham (UoN), including Dr Simpson and Dr Taylor, have conducted a rich and diverse research programme on human metabolism, diet and obesity in health, disease and exercise over the past twenty years.</p> <p>In a study published in 2000, Professor Macdonald and colleagues used MR Spectroscopy to measure the glycogen content in liver and skeletal muscle during exercise and recovery after either glucose or sucrose administration. The study was the first of its kind and concluded that both glucose and sucrose ingestion are sufficient to initiate the resynthesis of glycogen in the liver post exercise and that this results in increased endurance exercise capacity [1].</p> <p>In 2002, Professor Macdonald published a study with collaborators at the University of Oxford which explored the role of insulin in the regulation of blood flow in adipose (fat) tissue after nutrient ingestion, concluding that insulin does not have a direct role but is likely to be a mediator through sympathetic activation [2].</p> <p>Professor Macdonald and Dr Taylor participated in a European consortium to deliver a hypocaloric intervention programme that randomised 771 people with obesity to either a low or a medium fat content diet. The trial was part of the European Commission funded NUtrient-GENe interactions in human OBesity project (NUGENOB) [9]. Professor Macdonald and Dr Taylor led the design and implementation of the dietary assessment and intervention across the consortium, developed standard operating procedures, and</p> |   |   |

participated in the Steering Committee, data management and manuscript drafting groups. The results, published in 2006, showed that the two diets were successful in producing a significant weight loss. The low-fat diet group had fewer drop-outs and more individuals achieved a weight loss of more than 10% of their initial body weight [3].

In 2005, Professor Macdonald and Dr Taylor led the UoN participation in a randomised trial of four commercially available weight loss programmes which differed in their fat/carbohydrate content, carried out by five UK universities and funded by the BBC [10]. Professor Macdonald was the UoN PI and had a major role in study design, data interpretation and producing the publications. This study showed a significant and similar efficacy in aiding weight-loss of all four programmes. However, differences in blood lipids and lipoprotein content were uncovered, with implications for cardiovascular disease risk [4]. A smaller study involving healthy women, funded by the Sugar Bureau [11] and published by Professor Macdonald and Dr Simpson in 2008, showed a link between symptoms of hypoglycaemia and consumption of high sugar diets [5]. In further work, they compared substrate metabolism and appetite response in sedentary women who had either consumed a low or high-glycemic index breakfast and showed that a controlled but realistic diet protocol can optimise weight management [6]. In a later study of appetite and satiety (2014), the UoN team compared the effect of two between-meal snacks of equal caloric content but differing protein and soluble fibre content. The results showed that energy intake during the following meal was markedly reduced when the snack with whey protein and polydextrose was consumed in comparison to a control snack [7]. These two studies on metabolism were funded by Mars Inc [12].

A double-blind study by Professor Macdonald and Dr Taylor in 2013 compared the contribution of a high-fructose versus a high-glucose diet to non-fatty liver disease (NAFLD). NAFLD is prevalent in the UK and has been partially associated with obesity, insulin resistance, genetics and life-style factors. However, there is no clear understanding of how the diet of the individual impacts on liver fat metabolism. The study concluded that liver fat content increased when overweight men were overfed, but there was no difference between fructose and glucose overfeeding [8].

In summary, pioneering research led by Professor Macdonald and his team at UoN has revealed specific and applicable dietary interventions that can be used to control weight management of the individual and therefore steer national obesity trends. This body of research work has led to invitations for Professor Macdonald to join several governmental committees, including SACN [13-16]. Professor Macdonald is Editor in Chief of the International Journal of Obesity and was President of the Nutrition Society from 2007 to 2010. Additionally, three of the publications highlighted here [3, 4, 8] were referenced in the 2015 SACN 'Carbohydrates and Health' report, where [8] was of major importance, showing similar effects of both fructose and glucose overfeeding in increasing liver fat content.

### 3. References to the research

**Key references** (Bold text indicates University of Nottingham staff or PhD student at the time the research was undertaken)

- 1 **Casey A, Mann R, Banister K, Fox J, Morris PG, Macdonald IA and Greenhaff PL** (2000). Effect of carbohydrate ingestion on glycogen resynthesis in human liver and skeletal muscle, measured by <sup>13</sup>C MRS. *American Journal of Physiology*, 278, E65-75. doi: 10.1152/ajpendo.2000.278.1.E65
- 2 Karpe F, Fielding BA, Ardilouze JL., Ilic V, **Macdonald IA** and Frayn KN (2002). Effects of insulin on adipose tissue blood flow in man. *Journal of Physiology*, 540.3, 1087-1093. doi: 10.1113/jphysiol.2001.013358
- 3 Petersen M, **Taylor MA**, Saris WHM, Verdich C, Toubro S, **Macdonald IA**, Rössner S, Stich V, Guy-Grand B, Langin D, Martinez JA, Pedersen O, Holst C, Sørensen TIA, Astrup (2006). A Randomized, multi-center trial of two hypo-energetic diets in obese subjects: High- versus low-fat content. *International Journal of Obesity*; 30:552. doi: 10.1038/sj.ijo.0803186
- 4 Morgan LM, Griffin BA, Millward DJ, DeLooy A, Fox KR, Baic S, Bonham MP, Wallace JMW, **Macdonald IA, Taylor MA, Truby H** (2008). Comparison of the effects of four

commercially available weight-loss programmes on lipid-based cardiovascular risk factors. *Public Health Nutr.* 12(6):799. doi: 10.1017/S1368980008003236

**5 Simpson EJ, Holdsworth M, Macdonald IA** (2008). Interstitial glucose profile associated with symptoms attributed to hypoglycemia by otherwise healthy women. *American Journal of Clinical Nutrition*; 87:354. doi: 10.1093/ajcn/87.2.354

**6 Stevenson EJ, Astbury NM, Simpson EJ, Taylor MA, Macdonald IA** (2009). Fat oxidation during exercise and satiety during recovery are increased following a low-glycemic index breakfast in sedentary women. *Journal of Nutrition*; 139:1227. doi: 10.3945/jn.108.101956

**7 Astbury NM, Taylor MA, French SJ, Macdonald IA** (2014). Snacks containing whey protein and polydextrose induce a sustained reduction in daily energy intake over 2 wk under free-living conditions. *American Journal of Clinical Nutrition*; 99:1131. doi: 10.3945/ajcn.113.075978

**8 Johnston RD, Stephenson MC, Crossland H, Cordon SM, Palcidi E, Cox EF, Taylor MA, Aithal GP, Macdonald IA** (2013). No difference between high-fructose and high-glucose diets on liver triacylglycerol or biochemistry in healthy overweight men. *Gastroenterology*; 145:1016. doi: 10.1053/j.gastro.2013.07.012

#### Key Grants:

**9** 2001-04, European Commission / FP5 Life quality, "Nutrient-gene interaction in human obesity: Implications for dietary guidelines", **Macdonald** UoN PI, EUR4,011,634 (total), EUR235,419 (UoN share)

**10** 2003-04, BBC Diet Trial, **Macdonald** Col (University of Surrey as lead), GBP70,045 (UoN share)

**11** 2000-04, Sugar Bureau, "The sugar rush studies", **Simpson** PI, **Macdonald** Col GBP76,017.

**12** 2004-10, Mars Chocolate UK Ltd, "Metabolic consequences of dietary alteration", **Macdonald** PI, **Taylor** Col, GBP501,970.

#### Macdonald's Government Committees memberships:

**13** Obesity Review Group (Ministerial Committee for Minister for Public Health), 2011-15

**14** Food Network Component of the Responsibility Deal at Department of Health, 2011-15

**15** Reference Panel for the National Audit Office Obesity Study, 2000-02

**16** UK government Scientific Advisory Committee for Nutrition (SACN), 2004-20; Carbohydrates Working Group, Macdonald as Chair, 2008-15

#### 4. Details of the impact

Professor Macdonald was appointed member of the UK Scientific Advisory Committee on Nutrition (SACN) in 2004. The SACN advises Public Health England (PHE) and other government agencies, providing the scientific basis for the development of policy on nutrition. Appointments to SACN are made in accordance with the principles of the *Code of Practice of the Scientific Advisory Committees* and the *Governance Code for Public Appointments* that underpin all UK government public appointments and are made on merit. Professor Macdonald's research over the last 30 years, partly illustrated in the underpinning research section [1, 2], formed the basis of the scientific expertise which the Department of Health, the Food Standards Agency and Chair of SACN judged as appropriate to appoint Professor Macdonald as member of SACN. Macdonald acted as Chair of the Carbohydrates Working Group within SACN since its inception (2008-2015), an appointment "based on [his] longstanding expertise in the nutritional and physiological aspects of carbohydrate metabolism in health and disease" [S1]. The Carbohydrates Working Group published the *Carbohydrates and Health Report* in 2015 [S2], citing three of Professor Macdonald's key publications [3, 4, 8] and recommending: the average intake of free sugars not to exceed 5% of total dietary energy; minimised consumption of sugary drinks; and the adoption and definition of the term 'free sugars'.

Testament of the commitment of Professor Macdonald to this report, the Chair of SACN stated in the preface to the report: "This has been a challenging and large undertaking for SACN and I would like to thank the Carbohydrates Working Group, particularly the Chair, Professor Ian Macdonald, and the Secretariat for their great commitment in producing this report." [S2]. She also said "Professor Macdonald's leadership and scientific expertise

*proved pivotal in steering the Working Group through to achieving consensus on the evidence from a very large volume of published data and to providing clear advice to SACN and ultimately to the UK governments and the public” [S3].* Chief nutritionist and Deputy Director of Diet, Obesity and Physical activity of PHE said “SACN’s input into the evidence base underpinning nutrition policy and advice is greatly appreciated by PHE and the four UK health departments. Without the expertise offered by members of the Committee, such as yourself [Professor Macdonald], PHE would be unable to advise the UK government in the best possible way on nutrition science. PHE greatly appreciates this contribution towards public health and the translation of research evidence into practice and policy” [S1].

The Carbohydrates and Health Report publication resulted in the introduction of new public health policy and legislation by the UK government: the Soft Drinks Industry Levy (SDIL)  
As part of the March 2016 Budget, following the recommendations of the *Carbohydrates and Health Report*, the then Chancellor George Osborne announced the introduction of the SDIL [S4] on industries selling sugary drinks, with the objective of encouraging producers to reformulate their products to contain less sugar and reduce sugar consumption. Industries were given two years to reformulate their products and the levy became law in April 2018. The SDIL, popularly known as the Sugar Tax, became part of the wider government’s ‘*Childhood Obesity, a Plan for Action*’, published in August 2016 [S5], which references the *Carbohydrates and Health Report* explaining the levy alongside further measures to promote a healthy lifestyle in children.

The *Carbohydrates and Health Report* has had wide UK reach through several government initiatives such as the PHE School Food Standards and the PHE Public Sector Catering; through the continuing national campaign on healthy eating such as *Change4Life*, *Start4Life* and *Nutrient Profiling*; and through devolved government policy such as the *Eating Well Choosing Better Programme* (Food Standard Agency of Northern Ireland) and the *Out of Homes Strategies* (Food Standards Scotland) [S3].

Introduction of the SDIL resulted in significant reduction of sugar consumption in the UK  
Introduction of the levy has encouraged approximately 50% of the soft drinks manufacturers to reformulate their products. PHE reported that in the UK sugar levels per 100mL fell by 11% and 28.8% in the 2015-17 and 2015-18 periods respectively and that there has been a consumer shift towards zero or lower sugar products and a reduced portion size. In all, ‘30,133 tonnes of sugar were removed without reducing soft drink sales, resulting in around 37.5 billion fewer kilocalories sold in sugary drinks each year’ [S6]. A separate study by the University of Oxford published in 2020 sought to assess the changes by consumers and soft drink companies between 2015 and 2018 in response to the introduction of the SDIL. Results showed that “the volume of sugars sold per capita per day from soft drinks declined by 30%, equivalent to a reduction of 4.6 g per capita per day” [S7].

Professor Macdonald’s interaction with the food industry has also positively impacted sugar consumption. Professor Macdonald was a member of Mars Scientific Advisory Council (MSAC, 2015-19) and Mars European Nutrition Advisory Group (ENAB, 2006-11, 2015-20). He was instrumental in developing their understanding of a balanced diet and influencing them towards a strategy of size reduction. His advice became the basis of the *Mars Confectionary Health and Wellbeing Strategy*, as well as the *Mars Advertising Code*, both of which are implemented to date and include reduced portion sizes and reduced sugar and saturated fat content [S8].

Introduction of the SDIL resulted in improved children’s dental health  
Sugary drink intake increases the incidence of tooth decay. Evidence about poor dental health in the UK and a need to improve it influenced the target of daily carbohydrate intake agreed in the *Carbohydrates and Health Report* [S2]. The publication of the report, the introduction of the SDIL and the reduction of sugar levels in sugary drinks have all contributed to the trend of significant improvement of English children’s dental health, from



27.9% of 5-year old children presenting obvious tooth decay in 2012 down to 23.4% in 2019 [S9].

Introduction of the SDIL resulted in UK government investment in school health programmes and did not result in lasting negative economic impact for UK soft drink industry.

HMRC data on the monies collected from SDIL for the first two quarterly return periods immediately after the introduction of the tax shows 457 individual live traders registered for the levy, raising a total of GBP153,800,000 from April to October 31<sup>st</sup> 2018 [S10]. The UK government committed to spending money raised by the SDIL on facilities to support physical education, after-school activities and healthy eating initiatives in primary, secondary and sixth-form colleges. GBP415,000,000 was to be made available to schools in the 2018/2019 financial year regardless of the total amount raised by the levy [S10].

The SDIL has not had a negative impact on the UK soft drinks industry. Although stock market returns for these companies were negative on the day the SDIL was announced, the returns bounced back on the following four days and stock prices increased over the following 2 years. Additionally, while UK sales of drinks subject to SDIL has fallen by 50% from 2015 to 2018, the volume of sales of low- and zero- sugar drinks and bottled water rose by 40% and 23% respectively [S11].

Media coverage of the SDIL resulted in increased public debate and awareness of sugar intake

The “sugar tax” has been widely covered in the UK and international media, where it was hailed as “*a major change in health and tax policy*”. This extensive coverage raised public awareness of the health impacts of excessive sugar consumption and sparked a more general debate among members of the public on health and nutrition. This debate even became a fault line in British politics more widely. The health secretary Matt Hancock praised the sugar tax: “*proving that population-wide measures work and are necessary, alongside promoting healthier behaviours and empowering individuals to make better choices*” [S12].

**5. Sources to corroborate the impact** (websites were last accessed on 18/01/2021)

**S1** Letter of support from Chief Nutritionist and Deputy Director of *Diet, Obesity and Physical Activity* of PHE.

**S2** SACN *Carbohydrates and Health Report* published 17<sup>th</sup> July 2015; Citation of Macdonald’s publications: [3] p. 43, 44, 45, 58, 60; [4] p. 50, 51, 59, 60, 70; [8], p. 209.

**S3** Letter of support from the Chair of SACN

**S4** UK Government briefing summary of SDIL, [web link](#)

**S5** UK Government’s ‘Childhood Obesity, a plan for action’, which references the Carbohydrates and Health report (ref16), [web link](#)

**S6** PHE reviews of the reformulation programme (2018 report p.1-101; 2019 report p.102-209)

**S7** 2020 study by the University of Oxford of the changes by consumers and soft drink companies between 2015 and 2018 in response to the introduction of the SDIL, [web link](#)

**S8** Letter of support of Global Nutrition & S&RA Director of Mars Food.

**S9** PHE Oral health survey of five-year-old children 2019, [web link](#)

**S10** House of Commons Briefing Paper, 2020 [web link](#)

**S11** NIHR economic evaluation of the SDIL: two NIHR funded studies (concatenated in 1 document) show the lack of negative economic impact to industry by the introduction of SDIL

**S12** UK Health and Social Care Secretary’s speech on obesity, January 2019, [web link](#)