Institution: Newcastle University		
Unit of Assessment: UoA 2		
Title of case study: Intake24: a free and accurate online food intake measure		
Period when the underpinning research was undertaken: 2008-2018		
Details of staff conducting the underpinning research from the submitting unit:		
Name(s):	**Role(s) (e.g. job title):**	**Period(s) employed by submitting HEI:**
Dr Emma Foster	Principal investigator (YPFA and Intake24)	January 2002-December 2018
Prof Ashley Adamson	Co-applicant (YPFA and Intake24)	September 1994-present
Prof Patrick Olivier	Co-applicant (Intake24)	August 2004-December 2018
Prof John Matthews	Co-applicant (YPFA and Intake24) Professor of Human Nutrition	March 1987-present
Prof John Mathers	Co-applicant (YPFA)	October 1983-present
Prof John Lloyd	Co-applicant (YPFA)	September 1970-October 2008 1981-present
Prof Lindsay Marshall	Principal Research Associate	April 2014
Dr Wendy Wrieden	Research Assistant	March 2011-September 2019
Dr Emma Simpson	Research Assistant	January 2008-present
Ms Jennifer Bradley	Research Assistant	July 2015-present
Ms Maisie Rowland	Research Assistant	December 2007-March 2011
Mr Adrian Hawkins	Software Developer (Senior	January 2012-present
Dr Ivan Poliakov	Research Associate)	
Mr Dan Jackson	Senior Research Associate	August 2005-present
Period when the claimed impact occurred: 2016-present		
Is this case study continued from a case study submitted in 2014? No		

1. Summary of the impact

Assessing the population's diet is essential for monitoring public health and evaluating the impact of campaigns, but traditional methods are time-consuming, impractical and expensive. Newcastle University therefore developed Intake24, an accurate and user-friendly online food diary. Users input their food intake over the past 24 hours and the system automatically codes their responses, providing substantial time and cost savings. A major innovation, Intake24 was used by Public Health England to assess the Government's "Sugar Smart" campaign, saving around £250,000. It was recently adopted into the National Diet and Nutrition Survey to assess population dietary intake across the UK, and has been used by Coeliac UK to assess the intakes of 1,000 people following a gluten-free diet. Intake24 was also used to assess the diets of 16,000 participants in Denmark and Portugal, saving £50,000. A successful pilot of Intake24 in the 2018/19 Scottish Health Survey led Food Standards Scotland to adopt the system for subsequent surveys.

2. Underpinning research

Unmet need

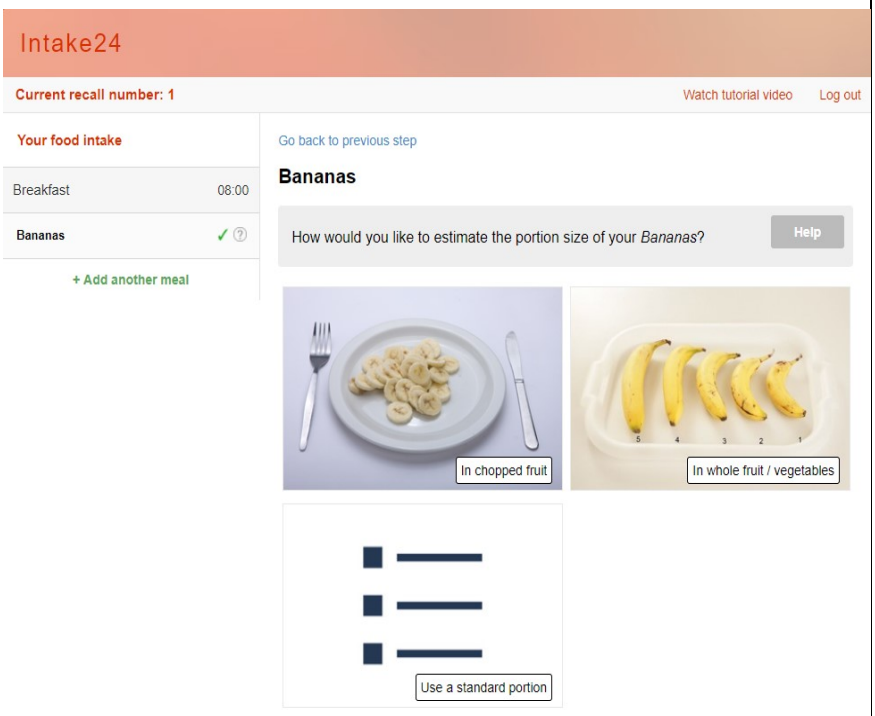
Government agencies such as Public Health England (PHE) monitor the population's dietary intake for risk assessment, appropriate targeting of nutrition-related policies and to monitor the outcome of campaigns. To calculate the constituent nutrients of a diet, accurate portion size measurement is crucial. Although the most accurate measure is a weighed food diary, their completion requires substantial subject training and motivation. This considerable burden reduces participation and completion rates, resulting in lower quality data. In addition, coding and analysis of the diaries requires considerable time, expertise and cost. Newcastle therefore developed Intake24, an accurate and user-friendly system where users input the food and drink that they remember eating over the past 24 hours (a "recall"), and the system automatically records the nutritional composition and gram weight of each item.

The development of Intake24

The research began by comparing three tools that improve the accuracy of portion size estimation: food photographs, food models and a novel interactive portion size assessment system developed by Newcastle (R1). This system allows the user to scroll through photographs of real foods depicting various portion sizes, select the image that most closely represents what they ate and

indicate any food left over. Estimates using the system were closer to the actual weight and nutrient content of food eaten than the photographs or models, and showed the least variability.

The next study (R2) improved the original system and expanded the range of food types to 104 and images to over 1,300, including the top 100 from the most recent National Diet and Nutrition Survey. The updated system showed good accuracy and fair precision compared to 4-day weighed intakes.



Having established sufficient accuracy, the next step was to develop a computerised system, now known as Intake24. This iteration of the system (R3) included adaptations to enable self-completion, such as a search function and instructions to add meals, snacks and drinks consumed the previous day.

Intake24 was further developed with four cycles of iterative feedback from users (R4 and R5). The search function was refined to recognise misspelt words, brand names, phonetic spelling and phonemes, and added cues such as requesting further detail when the user provided insufficient information. Since the system was intended to monitor population diet, large-scale availability was a key feature and it was therefore developed to allow online access. The system was compared to interviewer-led 24-hour recalls, considered by many as the gold standard of dietary assessment, and was found to provide estimates of energy intake that were just 1% lower on average than the interviewer-led recall. In addition, 85% of all foods and drinks recorded were an exact match. Using an industry-standard System Usability Scale to measure user friendliness, the system was rated as 83/100 where over 80 is considered excellent[1]. The ease of completing Intake24 and minimal training required improves participants' motivation and therefore completion rates.

Finally, the system was field tested with participants aged 11 to 65+ years who had previously taken part in the Scottish Health Survey (R6). Of the 132 participants who completed four or more recalls, over 80% agreed that Intake24 was easy to follow and understand, and completion took an average of 14 minutes. There were only a small number of requests for help, of which the vast majority were resolved in less than 10 minutes.

This iterative development with user feedback allowed the development of a powerful, intuitive and accurate system suitable for use in national surveys of population diet. Its adoption into such surveys is described below.

3. References to the research

SciVal field-weighted citation impact (FWCI) as of December 2020. Newcastle researchers in **bold.**

R1. **Foster E**, **Matthews JNS**, **Lloyd J**, **Marshall L**, **Mathers JCM**, Nelson M, Wrieden WL, **Cornellisen P**, Harris J and **Adamson AJ**. (2008) Children's estimates of food portion size: the development and evaluation of three portion size assessment tools for use with

[1]Bangor et al. 2009 https://dl.acm.org/doi/10.5555/2835587.2835589

children. *British Journal of Nutrition*. 99:175-184. DOI: 10.1017/S000711450779390X. FWCI: 1.68.
R2. **Foster E**, **Hawkins A**, **Simpson E**, **Adamson AJ**. (2014) Developing an interactive portion size assessment system (IPSAS) for use with children. *Journal of Human Nutrition and Dietetics*. **27**(Supplement 1):18-25. DOI: 10.1111/jhn.12127. FWCI: 1.47.
R3. **Foster E**, **Hawkins A**, **Delve J**, **Adamson AJ**. (2014) Reducing the cost of dietary assessment: Self-Completed Recall and Analysis of Nutrition for use with children (SCRAN24). *Journal of Human Nutrition and Dietetics*. **27**(Supplement 1):26-35. DOI: 10.1111/jhn.12108. FWCI: 1.7.
R4. **Simpson E**, **Bradley J**, **Poliakov I**, **Jackson D**, **Olivier P**, **Adamson AJ**, **Foster E**. (2017) Iterative development of an online dietary recall tool: INTAKE24. *Nutrients. 9(2)118. DOI: 10.3390/nu9020118.* FWCI: *1.83.*
R5. **Bradley J**, **Simpson E**, **Poliakov I**, **Matthews JNS**, **Olivier P**, **Adamson AJ**, **Foster E**. (2016) Comparison of INTAKE24 (an Online 24-h Dietary Recall Tool) with Interviewer-Led 24-h Recall in 11–24 Year-Olds. *Nutrients*. *8:*358. DOI: 10.3390/nu8060358. FWCI: 2.32.
R6. **Rowland MK**, **Adamson AJ**, **Poliakov I**, **Bradley J**, **Simpson E**, **Olivier P**, **Foster E**. (2018) Field testing of the use of Intake24 – an online 24hr dietary recall system. *Nutrients.* 10(11):1690. DOI: 10.3390/nu10111690. FWCI: 0.44.

4. Details of the impact

Advantages of Intake24

The main advantage offered by Intake24 (available at intake24.co.uk) is removing the need for a trained nutritionist to visit the participant's home to conduct an interview, which typically lasts an hour, and then code this information, which can take a further hour. Using this online system also avoids the need for planning the logistics of these visits, therefore offering substantial savings in terms of cost and time. For the participant, Intake24 offers convenience, as the recalls can be completed at a time and place suitable for them, and do not have to be completed in one go. The reduced burden may increase participants' motivation to complete the recall and also discourage them from changing their dietary intake to facilitate recording. Another related advantage of Intake24 is that it removes social desirability bias, where a participant answers in a manner that would be viewed favourably by others, since there is no interviewer present. The system can also provide immediate dietary feedback to the user, which has been reported to be very useful. Finally, the automatic coding of the data means that accuracy does not vary with the experience and diligence of the researcher. Unlike another UK-based tool (myfood24), Intake24 has adopted all aspects of the US Department of Agriculture's Automated Multiple Pass Method and is free of charge.

Use of Intake24 to assess UK population dietary intake

To date, Intake24 has been used in four major programmes that assessed the UK population's diet, providing crucial data to support risk assessment, policy development (including monitoring and evaluation) and inform further public health campaigns.

The first was the "Sugar Smart" campaign, which ran in early 2016 as part of Change4Life, the Government's brand to tackle childhood obesity in England. Public Health England (PHE) chose Intake24 to assess the campaign as it provided a more rapid and less invasive approach than traditional methods involving face-to-face interviews or the collection of blood and urine samples. Intake24 was used to assess around 3,300 diets and allowed PHE to save substantial costs of approximately £250,000 (EV1).

The second campaign was the National Diet and Nutrition Survey (NDNS), a rolling programme established in 2008 to assess UK public diet, nutrient intake and nutritional status. In 2018, NatCen Social Research and the MRC Epidemiology Unit at Cambridge University were awarded the contract to deliver the third wave of the NDNS (2018–2023), a pivotal objective of which was to move the survey from a paper food diary to a digital assessment tool. After a detailed review of the methods available, Intake24 stood out as a strong candidate for the NDNS due to published

evidence of its usability, validity and performance, its completeness of data collection, ease of use and acceptability to participants, its open-source nature and the potential for adaptation and customisation (EV1, EV2). Further development of Intake24 since 2018 has been undertaken in conjunction with Cambridge University, and in October 2019 it was launched in the NDNS to collect data from 1,200 people over the subsequent year. Fieldwork was suspended in March 2020 with the outbreak of COVID-19, but early evaluation results were positive (EV2).

Thirdly, the charity Coeliac UK used Intake24 in the specific Coeliac Diet and Nutrition Survey (CDNS, EV3) to assess the diets of people with coeliac disease, following a strictly gluten-free diet, who were not covered by the NDNS. Using Intake24, a pilot of the CDNS began in 2017 and its success led to full roll-out in March 2018, with data collection completed in July 2019. During the project, Intake24 was used to collect 1,331 recalls once a day for four days – a total of 5,324 individual recalls. Intake24 allowed Coeliac UK to assess food intake with a larger number of participants more rapidly and at a lower cost than traditional methods. In addition, feedback collected following the most recent phase of the CDNS identified that 88% of respondents found using Intake24 easy or very easy (EV3).

Finally, Intake24 was piloted by Food Standards Scotland (FSS) in 2018/19, assessing a total of 2,112 recalls (EV4). Of the 800 respondents that provided feedback in the pilot, 87% felt they were able to complete Intake24 in a reasonable time and 33% said that they would make changes to their diet as a result of completing the recall. The approach taken to integrate Intake24 into the Survey was broadly successful. (EV5). The success of this pilot led FSS to take the decision in November 2020 to use Intake24 for the Survey, starting in 2021, with around 2,500 participants per year.

Use in a European study of weight loss maintenance

Intake24 was also used in the NoHow programme to investigate the maintenance of weight loss. NoHow, which ran from March 2017 to October 2019, was an international project involving partners in Denmark, Portugal and the UK. Intake24 was used to assess around 16,000 recalls (over 5,100 were the English version, over 5,500 the Portuguese version and 5,300 the Danish version). The system allowed the project to assess food intake more rapidly and less invasively than traditional methods, and offered a cost saving of around £50,000 (EV6). Feedback from participants included 60% saying they found it easy to use, and around 38% saying it helped with weight control (EV7).

In summary, Newcastle developed a powerful, accurate and intuitive tool to collect population-level dietary intake that offers cost savings and reduced respondent burden.

5. Sources to corroborate the impact

EV1. Letter from Public Health England.
EV2. Letter from Programme Director – Measurement and Surveys, MRC Epidemiology Unit University of Cambridge.
EV3. Letter from Coeliac UK.
EV4. Letter from Food Standards Scotland.
EV5. Food Standards Scotland December 2020 report: Pilot of Intake24 in the Scottish Health Survey. Available at https://www.foodstandards.gov.scot/publications-and-research/publications/pilot-of-intake24-in-the-scottish-health-survey
EV6. Letter from lead of NoHow project.
EV7. Data can be provided on request.