Structured Abstract

Design/methodology/approach

The site where this experiment happens is a major London hospital, serving over a million patients every year. In the experiment, the hospital's snack and drink vending machines are redesigned. The impact on product sales are then analysed using robust statistical methods.

Purpose

The experiment introduces nutritional labelling, healthier products and product placement designs to the hospital vending machines, to promote healthy lifestyles.

Findings

Nutritional labelling has a statistically significant impact on product sales. Less of the unhealthiest products are sold. Healthier products and product placement designs have a larger impact but with less statistical significance. They require further testing.

Research Implications

Experts in service operations can use this experiment's regression modelling methods. The methods are ideal for measuring change over time in counting data sets in complex real world environments.

Practical Implications

There are suggestions for practical vending service change in this research. They are in line and add a practical example to Government policy guidance.

Social implications

People using the redesigned vending machines have more opportunity for healthy lifestyle choices.

Originality/value

The experiment provides statistical evidence in support of catering for healthier lifestyles.

Introduction

In a year, the vending machines in this hospital in this experiment sell nearly a ton of sugar, 20 kg salt and 300 kg saturated fat.

The photograph below shows one of the machines (Figure 1). The same kind of vending can be found across the UK and many countries.

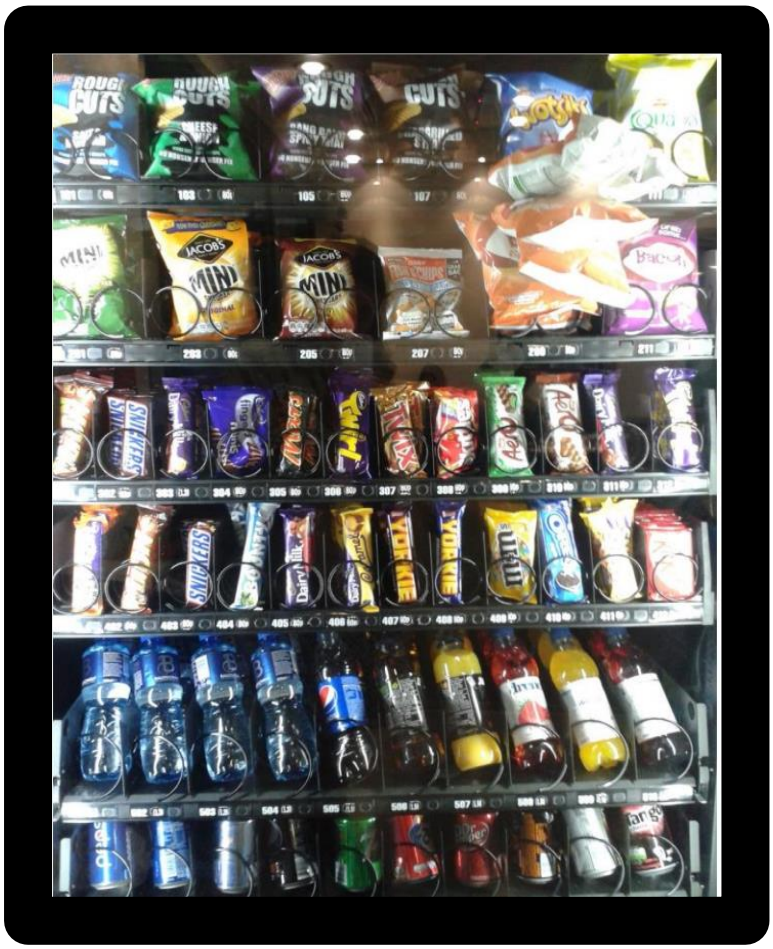

Figure 1 Photo taken by author (2018)

The same kind of vending can be found across the UK and many countries.

This high fat, salt and sugar vending is especially at odds with the hospital's role as health-care provider and research supports this. This kind of vending leads to an increased risk of preventable long-term diseases (Ermetici et al. 2016, Kelly et al. 2012, Maliderou et al. 2006, O'Hara and Haynes-Maslow 2015, Almeida et al. 2014, Gemmil and Cotugna 2005, Capacci et al. 2012, Chauliac and Hercberg 2012, Mesas et al. 2012, Muñoz-Pareja et al. 2013, Martin and Chauliac 2014).

In response to the problem, the UK and American Governments encourage healthier lifestyle choices with policy on vending. The French Government has taken stronger action and banned vending in places such as schools (Phillips et al. 2003, ten Have et al. 2010,

Terry-McElrath et al. 2014, Chauliac and Hercberg 2012, Capacci et al. 2012, Dubuisson et al. 2012, Martin and Chauliac 2014).

For hospitals and National Health Service (NHS) sites, the UK Government has issued special policy. It encourages healthier catering options. In particular, it suggests clear nutritional information and appropriate labelling (HFSP 2014, 5yfv 2014, WHO 2016, DoH 2014, Marmot 2010). While it can be applied to vending, there is no specific advice for vending machines.

The vending market has responded to concerns by creating healthier vending product ranges.

Another approach to the problem might be to harness common vending designs. They emphasise that products at eye level sell more (Figure 2).

Figure 2 Vending display hotspots (Campbell

These responses each encourage healthier lifestyle choices, rather than removing unhealthy ones altogether. They align with the UK Government policy. They also align to a popular service environment design called nudge theory. The theory is to create an environment where the designer's desired choice is the easiest one to make (Thaler and Sunstein 2008, Sterman 2000 p.537, Lockton et al. 2010, 2008, RAE 2016, Nenonen and Sarasoja 2014, BIFM 2013, Martin and Guerin 2006, Coenen and von Felton 2014, Mclennan 2004). The Government has a Behavioural Insights Team dedicated to Nudging people to make healthier choices across a range of policy areas.

Nutritional profiles can also help by revealing different nutritional values on each vending product. The Rayner (2005) model was developed and applied by the UK Government, the World Health Organisation and Australian and French Governments in healthy eating campaigns (ANSES, 2015; Jewell, 2008; Sloane, 2014). It is ideal for vending, as it provides a quick way to read nutritional score on the products. It was successfully applied in an NHS healthy eating vending initiative (Bolton NHS Foundation Trust, 2010). This is the first time,

to the researcher's knowledge, that the profile has been applied to vending and tested using robust statistical analysis.

Hypothesis

Point of sale design will reduce sales of the least healthy products, labelled red by introducing:

- **Nutritional labelling (Hypothesis 1)**
- **Substitution of products for the industries healthier range (Hypothesis 2)**
- **Placement of healthier products into hotspots (Hypothesis 3)**

Method

Point of Sale Designs

The experiment happens in a real world environment and so there is variability in the data. Machines might be in clinical, private, public or busy areas. Busy spaces might have two machines that split food and drink, while quieter locations only have one machine selling both food and drink. This complexity will require robust and adaptable interventions and methods of analysis.

First, for nutritional labels, red amber or green nutrition stickers are given to each product. This type of labelling makes it possible to quickly and easily compare nutrition, as back of packet labels aren't visible in vending.

Second, product replacement uses the healthier product range of the onsite vending company. This tests a market driven solution.

Finally, the experiment places water into vending hotspots. Moving water closer to the eye level was the only option available in the experiment, due to service contract restrictions.

Experimental Procedure

The experiment measures product sales over 54 weeks, form 34 vending machines.

- Hypothesis 1 Nutritional labelling is tested for between 12-24 weeks in 24 machines
- Hypothesis 2 Substitution is tested for 42 weeks in 4 machines (due to contractual restrictions)
- Hypothesis 3 Placement is tested for 42 weeks in 13 machines

The population sampling scheme is random, in the sense that anyone with access to the site where a vending machine is located is able to use it.

Posters are placed with the vending machines, explaining the experiment and providing contact details of people have questions.

Statistical modelling

The variability of the data in a real world environment means that mixed-effects multilevel regression is an ideal statistical method for the analysis. Mixed-effects is useful for categorical and continuous outcome measures, for multiple exposures and conditionals that can also be a mix of continuous and categorical. In this case, the measure was continuous and the outcomes were categorical. A mixed-effects approach also accounts for the outcome measures that are grouped within subjects and can be used on complex data and also where data is missing. For example if a machine was out of order.

Exposures and conditional variables that are modelled in the analysis against the outcomes are described below. A number of conditional variables can be considered in the analysis, if machines are situated in a clinical space or in a staff space, busy or quiet area or public or private space:

Exposures
Any intervention
Nutrition labels
Healthier product range
Moving water

Conditionals
Clinical space or not
Location busy or quiet space
Staff only or public space
Was water sold at location or not

Outcomes (given in %)
Red labelled drink sold
Red labelled food sold

Preliminary tests for normality of distribution (Shapiro-wilk test) are used to confirm if the method is viable. Paired T-Tests are also carried out as an initial check on the data before modelling.

Results

Hypothesis 1: Customers will buy less of the red products, when the point of sale includes nutritional labels

The sale of red food decreases by approximately 2.5% in machines where traffic light labels are installed compared to those that aren't changed, adjusting for the other factors. The P-Value is 0.025 with a confidence interval between -4.60 and -0.30.

The sale of red drinks also decreases by approximately 5% in machines where traffic light labels are installed compared to those that aren't changed, adjusting for the other factors. The P-Value is 0.005 with a confidence interval between -8.46 and -1.53. There is a small but

significant reduction in red product sales when nutritional labelling of red amber green stickers is used.

Hypothesis 2: Customers will buy less of the red products when the point of sale includes a healthier product range

The sale of red foods reduces by 35.69% in machines where products are changed for the healthier product range compared to those that aren't changed, adjusting for the other factors. The P-Value is >0.000 with a confidence interval between -42.42 and -28.96.

The sale of red drinks reduces by just over 10% in machines have products changed for the healthier product range compared to those that aren't changed, adjusting for the other factors. The P-Value is >0.000 with a confidence interval between -15.78 and -4.98.

There is a large and significant reduction in red product sales when products are substituted compared to nutritional labelling interventions.

Hypothesis 3: Customers will buy less of the red products when the point of sale includes water closer to eye level

The paired t-test results show that the sale of red drinks decrease by approximately 4% as a result moving water to eye level, with a P-value of 0.0027 with a confidence interval between -7.01 and -1.84. This indicates that there is a small but significant change due to product placement. This indication is not carried over in the regression.

Different spaces in the hospital

The regression analysis highlights significant differences in clinical VS non clinical and public VS non-public areas of the hospitals. In clinical spaces, the sale of red products is 5.74% lower than non-clinical spaces, adjusting for the other factors. The P-Value is 0.03 with a confidence interval between -10.90 and -0.57

In busy spaces, the sale of red food is nearly 5% higher when compared to those that are in quieter areas, adjusting for the other factors. The P-Value is 0.048 with a confidence interval between 0.04 and 9.60.

Discussion

Nutritional labels make a small but statistically significant improvement, towards promoting healthier lifestyles. It is a low-cost intervention that could make a cumulative difference if applied across a large volume of vending machines.

The nutritional labels are adapted from UK Government guidance, as there is no vending specific advice available. The approach uses the well-used Rayner (2005) nutritional profile. The red amber green adaptation may be especially effective in vending, as it's not possible to read more complex back of packet information. The approach could also be used to set

service standards. For example if only green or amber foods and drinks within a catering contractor's product range were permitted in places such as hospitals.

Using the vending company's healthier product range reduces red product sales, far more than nutritional labelling. This is only a partial success, as sales drop significantly. Prices of healthier ranges are higher, which could be a contributing factor. It would be difficult to implement commercially viable changes without top down intervention that encourages fare prices and increased customer demand.

Moving water more to eye level makes a large reduction in red drink sales. To check if this is statistically significant, further testing would be required, on a larger population sample. Often water is sold out or not available in the vending machines. This suggests that water is a popular choice. It also suggests that there should be government guidelines to ensure that vending machines stock water at all times.

The best place in the hospital to promote healthy lifestyles is in busy areas. This is where testing is hardest. The vending company is reluctant to allow interventions here that might impact sales. This suggests that more top down intervention is required here too.

The interventions have a large and significant impact on the sale of red food in clinical areas. This suggests that there is more demand for healthier food in clinical areas and that this should be catered for more in future.

Conclusion

Policy guidance advises clear labelling of nutrition (HFSP 2014, 5yfv 2014, WHO 2016, HFSP 2014, DoH 2014, Marmot 2010). The results show that labelling yields a small but significant overall reduction in red product sales. They also suggest that Nudge policy approaches have to be scaled across many sites to create impact. In vending, this still leaves large concentrations of saturated fat, sugar and salt being sold where other catering options may not be available.

The results suggest that there are more targeted, clear guidance may be required, top down. For example, policy might dictate that water should be available in all vending machines. Guidelines might ensure that healthy alternatives are available in all vending machines, or a ban placed on the least healthy products.

The experiment highlights that selling high concentrations of fat, sugar and salt is a reputational risk to the NHS. The government advice can be adapted to promote healthier lifestyles. More significant action may be required, to build on the initial steps taken by Government.

Bibliography

1. 5yfv NHS England 2014. *NHS Five Year Forward View Report (5yfv):* NHS England.

2. Campbell L 2017. Using communication technologies to deliver public health agendas in National Health Service food and drink automated vending. Doctoral thesis (Eng.D), UCL (University College London).

3. Almeida FA, Wall SS, You W, Harden SM, Hill JL, Krippendorf BE 2014. The association between worksite physical environment and employee nutrition, and physical activity behaviour and weight status. *Journal of occupational and environmental medicine/American College of Occupational and Environmental Medicine* 56(7):779.

4. ANSES 2015. *Nutrition labelling: ANSES evaluates the feasibility of implementing the Rayner score available* at: https://www.anses.fr/fr/content/etiquetage-nutritionnel-l%E2%80%99anses-%C3%A9value-la-faisabilit%C3%A9-de-la-mise-en-%C5%93uvre-du-score-de-rayner, accessed 13.05.17.

5. BIFM (British Institute of Facilities Management) 2013. Sustainability in Facilities Management Report 2013. UK: BIFM. Available at http://www.sustainabilityinfm.org.uk/news/view/40, accessed 14/08/15.

6. Bolton NHS Foundation Trust 2010*. Changing the 'whole' food environment* '. Slide presentation available at https://www.slideshare.net/departmentofhealth/royal-bolton-hospital-changing-the-whole-food-environment.

7. Capacci S, Mazzocchi M, Shankar B 2012. Evaluation with Inadequate Data: The Impact of the French Vending Machine Ban. *2012 AAEA/EAAE Food Environment Symposium, May 30-31, Boston, MA*: Agricultural and Applied Economics Association.

8. Chauliac M, Hercberg S 2012. Changing the food environment: the French experience. *Advances in Nutrition: An International Review Journal* 3(4):605s-10s.

9. Coenen C, von Felten D 2014. A service-oriented perspective of facility management. *Facilities* 32(9/10):554-64.

10. DoH (Department of Health) 2014. *NHS staff health & wellbeing: CQUIN Supplementary guidance*. Available at: https://www.england.nhs.uk/wp-content/uploads/2016/03/HWB-CQUIN-Guidance.pdf, accessed 03/04/17, accessed 03/04/17.

11. Dubuisson C, Lioret S, Dufour A, Volatier J, Lafay L, Turck D 2012. Associations between usual school lunch attendance and eating habits and sedentary behaviour in French children and adolescents. *European journal of clinical nutrition* 66(12):1335-41.

12. Gase LN, Kuo T, Dunet, D, Schmidt SM, Simon PA, Fielding JE 2011. Estimating the potential health impact and costs of implementing a local policy for food procurement to reduce the consumption of sodium in the county of Los Angeles. *American journal of public health*, *101*(8), pp.1501-1507.

13. Ermetici F, Zelaschi RF, Briganti S, Dozio E, Gaeta M, Ambrogi F 2016. Association between a school-based intervention and adiposity outcomes in adolescents: *The Italian "EAT" project. Obesity* 24(3):687-95.

14. Gemmil E, Cotugna N 2005 Vending machine policies and practices in Delaware. *Journal of School Nursing*, 21(2):94-9.

15. HFSP (Hospital Food Standards Pan) el 2014 *Establishing food standards for NHS hospitals*: Department of Health (DoH).

16. Hua SV, Ickovics JR 2016. Vending Machines: A Narrative Review of Factors Influencing Items Purchased. *Journal of the Academy of Nutrition and Dietetics*, *116*(10):1578-1588.

17. Jewell 2008. *The chief medical officer for NHS Wales in his public letter on 'The Health Promoting Hospital Vending Directions to NHS Trusts'* Welsh Assembly Government: Cardiff.

18. Lockton D, Harrison D, Stanton N 2008. Design with intent: Persuasive technology in a wider context. *International Conference on Persuasive Technology:* Springer.

19. Maliderou M, Reeves S, Noble C 2006. The effect of social demographic factors, snack consumption and vending machine use on oral health of children living in London. *British dental journal* 201(7):441-4.

20. Marmot 2010 *Changing Lives, Our Vision for Public Health: Barts Health NHS Trust* containing the Marmot Review Team for Barts and The London NHS Trust 2010. Strategy for Health-promoting Hospitals Step 1: A framework for promoting staff health and well-being.

21. Martin CS, Guerin DA 2006. Using research to inform design solutions. *Journal of Facilities Management* 4(3):167-80.

22. Martin A, Chauliac M, Combris P, Delamaire C, Razanamahefa L, Soler L-G 2011. Le Programme National Nutrition Santé (PNNS) et l'offre alimentaire. *Cahiers de Nutrition et de Diététique* 46(2):S26-S35.

23. McLennan P 2004. Service operations management as a conceptual framework for facility management. *Facilities* 22(13/14):344-8.

24. Mesas AE, Guallar-Castillón P, León-Muñoz LM, Graciani A, López-García E, Gutiérrez-Fisac JL 2012. Obesity-related eating behaviors are associated with low physical activity and poor diet quality in Spain. *The Journal of nutrition* 142(7):1321-8.

25. Muñoz-Pareja M, Guallar-Castillón P, Mesas AE, López-García E, Rodríguez-Artalejo F 2013. Obesity-related eating behaviors are associated with higher food energy density and higher consumption of sugary and alcoholic beverages: a cross-sectional study. *PloS one* 8(10):e77137.

26. Nenonen S, Sarasoja AL 2014 (Sarasoja AL 2014). Facilities management research in Finland – state-of-art about current Finnish PhD-projects. *Facilities* 32(1/2)58-66.

27. O'hara JK, Haynes-Maslow L 2015. Examining the Association Between School Vending Machines and Children's Body Mass Index by Socioeconomic Status. *Journal of nutrition education and behaviour* 47(6):526-31e1.

28. Phillips MM, Kevin Ryan J, Raczynski JM 2011. Public policy versus individual rights in childhood obesity interventions: perspectives from the Arkansas experience with Act 1220 of 2003. *Public Policy* 8(5).

29. RAE (Royal Academy of Engineering) and ARUP 2015. *Built for living: Understanding behaviour and the built environment through engineering and design*. [online pdf].
30. Rayner M, Stockley L 2004*. Nutrient profiles: options for definitions for use in relation to food promotion and children's diets*. London: Food Standards Agency.

31. Rayner M, 2005. *The UK Ofcom Nutrient Profiling Model*. Oxford, UK: British Heart Foundation Health Promotion Research Group.

32. Skov LR., Lourenço S, Hansen GL, Mikkelsen BE, Schofield C 2013. Choice architecture as a means to change eating behaviour in self-service settings: a systematic review. *Obesity Prevention/Treatment* 14:187–196.

33. Sloane K 2014. Will the Health Star Rating labels improve people's diets? *Public Health Expert*. Published: University of Otago.

34. Sterman JD 2000. Business dynamics: systems thinking and modelling for a complex world. *Report No.: 0072311355.*

35. Ten Have M, de Beaufort I, Holm S, 2010. No Country for Fat Children? Ethical Questions Concerning Community-Based Programs to Prevent Obesity. *Preventing childhood obesity: Evidence policy and practice*, pp.31-39.

36. Terry-McElrath YM, Hood NE, Colabianchi N, O'Malley PM, Johnston LD 2014. Profits, commercial food supplier involvement, and school vending machine snack food availability: implications for implementing the new competitive foods rule. *Journal of School Health* 84(7):451-8.

37. Thaler, Cass R. Sunstein 2008. Nudge: Improving decisions about health, wealth, and happiness. *Constitutional Political Economy* 19(4):356-60.

38. WHO (World Health Organisation) 2016. WHO Regional Office for Europe nutrient profile model. Available online at: http://www.euro.who.int/__data/assets/pdf_file/0005/270716/Europe-nutrient-profile-model-2015-en.pdf .