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Applying Health Locus of Control and Latent Class Modelling to food and physical activity choices affecting CVD risk

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ABSTRACT

Health Locus of Control (HLC) classifies our beliefs about the connection between our actions and health outcomes (Skinner, 1996) into three categories: "internal control", corresponding to health being the result of an individual's effort and habits; "control by powerful others", whereby health depends on others, such as doctors; and "chance control", according to which health depends on fate and chance. Using Choice Experiments we investigate the relationship between HLC and willingness to change lifestyle, in terms of eating habits, physical activity and associated cardiovascular disease risk, in a 384 person sample representative of the 40–65 aged population of Northern Ireland administered between February and July 2011. Using latent class analysis we identify three discrete classes of people based on their HLC: the first class is sceptical about their capacity to control their health and certain unhealthy habits. Despite being unsatisfied with their situation, they are reluctant to accept behaviour changes. The second is a group of individuals unhappy with their current situation but willing to change through exercise and diet. Finally, a group of healthy optimists is identified, who are satisfied with their current situation but happy to take more physical activity and improve their diet. Our findings show that any policy designed to modify people's health related behaviour should consider the needs of this sceptical class which represents a considerable proportion of the population in the region.

1. Introduction

A premise for successful health promotion is to find individuals willing to modify their unhealthy life styles, but this will not occur as a result of providing information alone if the target group does not believe in the potential health benefits of behaviour change. Some people believe their health is controlled by luck, God's will or genetic factors (Rotter, 1966), i.e. by things beyond their control. Indeed, if people think that their health depends on factors that are beyond their control, they will be less willing to change their lifestyle, particularly if this requires certain sacrifices (Rosenstock et al., 1988). Conversely, healthy behaviour choices are more likely when accompanied by stronger beliefs in personal or internal control (Steptoe and Wardle, 2001).

The Health Locus of Control theory (HLC) posits that our health related behaviour is associated with the extent to which we believe in our own capacity to overcome health problems. Thus HLC is a construct that expresses the "beliefs about the connection between one's actions and outcomes" (Skinner, 1996). Rotter (1966) defined it as follows:

> When a reinforcement is perceived by the subject as […] not being entirely contingent upon his action, then, in our culture, it is typically perceived as the result of luck, chance, fate, as under the control of powerful others, or as unpredictable because of the great complexity of the forces surrounding him. When the

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event is interpreted in this way by an individual, we have labelled this a belief in external control. If the person perceives that the event is contingent upon his own behaviour or his own relatively permanent characteristics, we have termed this a belief in internal control. (p1)

HLC can be divided into three dimensions: "internal" (health is the result of an individual's effort and habits); "powerful others" (health depends on others, such as doctors) and lastly "chance" (health depends on fate and chance). *Internal* Locus of Control is also linked with perceived social norms in attitudes favourable to changes towards healthier lifestyles (Grotz et al., 2011).

Cardiovascular diseases (CVD) have a high prevalence in Northern Ireland (Hughes et al., 2010) and an unhealthy diet is regarded as a significant risk factor in this population (Hughes et al., 2013). Making improvements to the diet and physical activity levels of the population are among the main priorities of the public health authorities to prevent these conditions. Obesity is reaching pandemic proportions in many Western societies including Northern Ireland (World Health Organization, 2011) and both poor diet and lack of exercise are fuelling this rise in the region (Northern Ireland Health and Social Wellbeing Survey 2005/06).

Our paper explores the potential reaction of the target population to a health promotion campaign aimed at improving their lifestyles. We attempt to categorise and classify subgroups of the population using a Latent Class Model given the assumption that attitude to HLC may act as a source of heterogeneity in lifestyle choice.

In our notional intervention, we use Discrete Choice Experiments (DCE) to invite individuals to reduce their fat intake through dietary change, replacing unhealthy food with fruit and vegetables and by increasing the time devoted to moderate exercise. A positive cost is related to replacing unhealthy food and increasing exercise. The expected benefits in health are presented in terms of a reduction in the risk of a fatal CVD event over the next decade. The experiment is based on the individual's own baseline risk which is measured *ad hoc* per individual, with baseline diet and physical activity defined as the individual's actual dietary and exercise habits. Respondents can thus trade-off future CVD risk against changes in their current lifestyle.

The rest of the paper is organized at follows: first, we summarize the theoretical bases of discrete choice modelling and particularly, of the Latent Class Model; we describe the experiment, its attributes and details about the questionnaire. This is followed by the presentation of the model results, including a discussion of latent classes, and finally we draw out some conclusions.

2. Methodology, questionnaire and experimental design

2.1. Methodology

Discrete choice models are based on Random Utility Theory (RUT) (see, for example, Train, 2009) which considers situations where individuals face a finite set C of choice alternatives. Each alternative produces certain utility U which consists of a measurable or deterministic part V and another part that cannot be observed and which is represented by a random parameter ε. The deterministic component of utility V is decomposed into attributes (Lancaster, 1966) which can be measured while the model is estimated using choices made by the individuals between hypothetical scenarios (i.e. Stated Preferences).

$$U_j = V_j + \varepsilon_j = \beta_0 + \beta_1 X_{11} + \beta_2 X_{12} + \cdots + \beta_K X_{1k} + \varepsilon_j \quad (1)$$

The utility for an individual of alternative j is decomposed into the deterministic part V which, at the same time, can be expressed as the sum product of k attributes times their weight. The weight of each attribute is represented by betas and expresses the importance of each attribute in the utility function.

Depending on the assumptions made about the error term, different types of models are obtained. If the error term is assumed to be from a Type 1 extreme value distribution, then a multinomial logit (MNL) is obtained, which is the simplest model and the most popular (McFadden, 1974). Within the family of discrete choice models, the most widely used nowadays is the random parameters model which considers that the parameters k are distributed among the population to capture the heterogeneity of tastes. In this model the betas are not fixed but vary across respondents, and there is one parameter per individual (Train, 1998):

$$\boldsymbol{U_{ij}} = \tilde{\boldsymbol{\beta}}_{\boldsymbol{i}} \boldsymbol{x_{ij}} + \boldsymbol{\varepsilon_{ij}} \quad (2)$$

The utility function of each subject has some random parameter $\tilde{\beta}_i$ with values that depend on the values of the parameters θ of an underlying distribution$f(\beta|\theta)$. If beta is a continuous variable this model is a Random Parameter Logit (RPL); whereas if β_i is a discrete variable P_{ij} would be the sum of all conditioned probabilities of each value of β_i weighted by each probability $\beta_i = b$. This is known as the Latent Class Model (LCM), in which choice probability can be expressed as

$$\boldsymbol{P_{ij}} = \sum_{\boldsymbol{m}=1}^{\boldsymbol{M}} \boldsymbol{S_m P_{ij}}(\boldsymbol{\beta_i}) \quad (3)$$

Where M is a number of possible values of β. In this model, unobserved heterogeneity is represented by M latent classes in the population, each of which contains a specific parameter vector in the corresponding utility. In addition, a LCM can include a membership model that assigns individuals to classes based on their socioeconomic characteristic in the sample, so providing a useful interpretation of each segment.

2.2. Questionnaire

A multi stage random sample survey was administered by Social and Market Surveys Ltd between February and July 2011 to a randomly selected sample of households in the study area. Given the study objectives, we applied a filter restricting respondents to be between 40 and 65 years of age (following Krupnick et al., 2002). One respondent was selected for interview per household using a random procedure known as the Kish Grid. The final sample of 348 respondents had characteristics that resemble closely the characteristics of the Northern Ireland population (between 40 and 65) in terms of gender, age, income, and level of education (see Table 1). Ethical approval for this study was obtained from the Ethical Research Committee of the School of Biological Sciences, Queen's

Table 1
Comparing characteristics of the sample with the Northern Ireland population.

Characteristic	Census data	Sample
Mean age (years)	51.31	50.54
Employed	57.75%	50.54%
Unemployed	3.55%	12.64%
Student	0.24%	0.57%
Retired	9.77%	18%[a]
Looking after home/family	8.63%	6%
Permanently sick/disabled	15.21%	[a]
Women	50.82%	57%
Degree holders	25%	25%

[a] For the sample retired included permanent sick.