

Development of a Theory Based Dynamic Model on Demand for Obesity Preventive Goods

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Abstract Introduction: Obesity is one of the leading causes of preventable morbidity and mortality world-wide. The behavioural nature of the condition has been highlighted by the fact that it is largely the result of an energy imbalance between calories consumed and calories expended. In that respect, obesity related morbidity and mortality can be reduced through preventive behaviours. As behavioural scientists, economists have done little to date to explain and understand why the demand for obesity preventing activities is low. The aim of this paper is to develop an economic theory-based dynamic model to gain better understanding of people's obesity preventive behaviours. **Methods:** A literature search using a PICO approach was developed to identify the relevant variables considered to influence the demand for obesity preventive goods. To inform the model, a framework was developed to group variables and help determine appropriate linkages between them. **Results:** *Anchors, anxiety and anxiety driven variables* are fundamental influences of people's risk reduction actions. The anchors, which are environmental as well as personal in character, serve as references and stimulate anxieties. However, anxiety levels are driven by many other variables including stigma and perceived health outcomes. In response to one's anxiety an individual will take actions which can be explained, at least in part, by conventional economic theories particularly in terms of costs and utilities. **Conclusions:** Conventional economic theories of consumer behaviour cannot fully explain the demand for obesity preventive goods. The model demonstrates that many factors have to be considered including health economic, psychological and behavioural economic theories. The model should be tested through a well designed questionnaire before using it in a general adult population.

Keywords: *obesity, Behavioural Economics, preventive goods, demand, modelling*

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1. Introduction

The World Health Organisation has defined overweight and obesity as "abnormal or excessive fat accumulation that presents a risk to health [65]." For present purposes the term obesity is used to cover both 'overweight' (conventionally defined as a Body Mass Index (BMI) ≥ 25) and 'obese' (BMI ≥ 30). The high prevalence of obesity in the United Kingdom (UK) [42,54,55,56] and worldwide [15,31] is having profound impact on preventable morbidity, mortality [64] and reduced health related quality of life [3,22,28,33,43,61,66,68] with dire ramifications on the limited healthcare resources [8,10,11,14,16,18,20,37,41, 47,51,52].

The behavioural aspects of obesity are evident from the fact that obesity is mainly the result of an energy imbalance between calories consumed and calories expended. In that regard, obesity related morbidity and mortality can be reduced through preventive behaviours aimed at preventing or reducing obesity [57].

Economics is a behavioural science which explains consumer behaviour mainly through utility theory which, at its simplest, states that a consumer will demand a unit of a good if the utility (satisfaction) they get from consuming it exceeds its price. It has long been recognised within economics that the demand for healthcare does not quite fit within that paradigm since the utility which patients get from consuming healthcare (e.g. being examined, receiving injections, taking medicine, etc.) is clearly different from that derived from goods whose consumption they enjoy [12,26]. This led to a conceptualisation of the demand for healthcare as being derived from a more fundamental demand for health [21,26].

A "preventive good" has been defined as any good (or service) whose consumption reduces the risk of future ill health [12]. As obesity is associated with health risk, any good whose consumption reduces obesity can be regarded as a preventive good. Some obesity preventive goods, for example gastric band surgery or prescribed weight loss drugs are provided by health professionals, and economists have undertaken many evaluations to assess the cost effectiveness of these sorts of interventions

[6,38,40,44,58,62]. However, most of the ways in which people can prevent or reduce obesity do not involve formal health care systems but there is a paucity of economic studies on what influences people's obesity affecting behaviours [57]. It has been recognised, though, that demand for non-medical preventive goods is unlikely to be explained through conventional utility theory for the same reason as for medical care i.e. many obesity preventive goods such as exercise or low calorie foods, may not yield utility in the conventional sense [12].

The aim of this paper is to develop a theory-based dynamic model using conventional economic theory but also including elements of psycho-social behavioural theory to gain better understanding of people's preventive behaviours in the context of obesity.

2. Method

A systematic literature search using a Population, Intervention, Comparison and Outcome (PICO) [50,53] approach was followed to identify the relevant variables considered to influence the demand for obesity preventive goods. The PICO approach was used not only to define the research questions, the target population, identify the various interventions needed to prevent the development of the condition and the expected results, but importantly also the creation of a logical structure for the literature search and search terms.

The search terms included but were not limited to "obesity prevention, overweight prevention, weight gain prevention, demand for weight gain prevention, obesity/weight gain prevention factors, modelling preventive behaviours, factors for abnormal weight gain, demand for weight loss interventions, obesity/overweight – cultural factors, obesity/overweight – environmental factors, obesity/overweight – behavioural factors, obesity – diet and nutrition, overweight/obesity – risk factors, obesity prevention and lifestyle, obesity/overweight – economic factors, preventive behaviour – utility models, preventive behaviour – economic models." The main repositories used include PubMed Central, EcoBiz, EcoLit, Global Health, JSTOR, SSRN, NBER, Wiley Online Library, Elsevier, Science Direct and Anthropology online.

In order to produce the model, a framework was developed through which the identified variables which are hypothesised to affect the demand for obesity preventive goods were grouped into three categories; anchors, anxiety/anxiety driven variables and action oriented variables. The anchors serve as reference points for decisions and may ultimately trigger anxiety. However, the extent of one's anxiety is also influenced by a number of other variables (anxiety driven variables). Action oriented variables concern actions one will take as efforts to overcome the anxiety. These groupings, based on behavioural, health and conventional economics and psychological paradigms enable the linking of the variables based on their practicable and logical connections.

3. The Background Paradigms

3.1. Economic Theory of Demand

Traditional economic theory expresses demand as a two-dimensional function – a behavioural relationship between quantity demanded and the individual's maximum willingness to pay for incremental increases in quantity [21]. However, price is not the only determinant of quantity demanded. The individual's income, expectations, preferences, price of substitutes [32,35] and a myriad of other factors can be recognised as well.

The behavioural hypothesis suggests the consumer chooses a bundle of goods that is preferred to all other bundles that the individual can afford and maximises his/her utility [21]. This makes preference, choice and affordability (budget) essential elements in demand analysis. The theory of demand anchors on certain neoclassical or standard economic theories. Central to such theories is Pareto's concept of *homo economicus* (economic man)[69] which assumes that consumers are rational and that they make rational choices; the motivating factor is utility maximisation; utilities are purely governed by selfish interests and they assume that all income and assets are completely interchangeable [67].

However, the extent and nature of behavioural anomalies within the concept of *homo economicus* have been well documented [59,60], demonstrating deviations between neoclassical theories of human behaviours and actual human behaviours. In real world scenarios, individuals exhibit characteristics of altruism as well as spiteful tendencies [7,69] in decision making and social relationships. These include the considerations people have for others and their environment, having some sense of fairness and justice, being kind to other people they may not know, or the tendency to inflict harm on other people, for example, as a form of revenge or punishment.

In this respect, it is possible to criticise the neoclassical theorem on a number of grounds one of which is its assumption that consumer's preferences for current over future consumption are constant. A basic tenet of economics is that utility is not independent of when it arises with consumers putting a lower value on future, as compared with current utility. Thus consumers are willing to pay less (i.e. put a lower value) today for a good if they will have to wait one year to gain the utility, less still if they have to wait two years, and so on even if the utility will have the same nominal value at the time it's received. In the jargon they discount future utility at a rate determined by their own personal rate of time preference. Some of the relevant sets of neoclassical economic axioms and their limitations considered in the construction of this model are briefly discussed below.

3.2. Intertemporal Choice and the Case for Discounted Utility Model (DUM)

The outcomes of decisions people make between goods or bundle of goods occur at different points in time. Actions relating to obesity are no exceptions of such decisions. Intertemporal choice describes any decision that requires trade-offs involving outcomes that will have their effects at different times [46]. Conventional economic analysis of intertemporal choice is based on the perception that the effect of delay on the value of the outcomes happening in the future can be illustrated by a discount function [48].

As with other healthcare goods, the primary objective for the consumption of goods for the prevention of obesity and associated risks is the anticipated future health gains. The Discounted Utility Model (DUM) is one tool used by economists to analyse intertemporal choices [67] of trade-offs involving benefits that will accrue over time.

The use of DUM is based on the assumption that consumers evaluate the utilities resulting from decisions in similar ways that financial markets evaluate losses and profits from investments. It is based on the tenets that people are time consistent in their preferences, meaning they would feel just as favourable toward a consumption trade-off now as in one year or two years time or even more [48,67].

3.3. Models of Prevention

Outside the economic paradigms, many psychological based theories and models of prevention have been applied in public health.

The Health Belief Model (HBM) [12,25] is the most widely used psychosocial model. It is based on the understanding that individuals will take a health-related action only if they feel that the ill-health can be avoided; have positive expectations that by taking a recommended action, they will avoid the ill-health; and believe that they can take the recommended action successfully. It centres on four main constructs namely perceived susceptibility, perceived severity, perceived benefits, and perceived barriers.

3.4. Limitations of DUM and Psychological Models of Prevention

Obesity is largely a result of complex interactions between behavioural, socio-cultural and environmental factors [23,57]. These factors centre on sedentary lifestyles and consumption of unhealthy foods. It is widely accepted that those confronted with weight related problems have followed unhealthy lifestyles which implies that individuals may not necessarily be acting in a purely rational way. People also have emotions, prejudices and biases which influence their behaviour in many respects.

Experiments undertaken mainly by behavioural economists on intertemporal choice, suggest that most of the assumptions in discounted utility do not necessarily hold with regard to consumer behaviour. The first anomaly to contradict discounted utility was that the observed discount rates appear to decline over time. The experimental observation [9] was that people tend to consider delaying consumption by a bigger sacrifice when the benefit is closer in time rather than when it is farther in the future. This means the closer (in time) the benefit is, the bigger the sacrifice people are willing to take. Such declining discounted rates revealing 'decreasing impatience' [45] became known as *hyperbolic discounting* [13,24,39]. The discovery of Hyperbolic discounting not only proved to be a direct challenge to discounted utility, but paved the way for more empirical testing which discovered a host of other anomalies now present in the intertemporal choice theory literature. Behavioural Economists also showed that individual decisions are contextual [9] and influenced by many other factors not necessarily utility only. Those factors on which decisions

are based are referred to within the model presented here, as anchors [67].

HBM also has several limitations that can limit its use in public health. First, HBM does not account for other factors that influence people's acceptance or otherwise of a health behaviour such as the person's attitudes, habitual behaviours (e.g. addictions), issues of social acceptability (hence stigma), cultural factors and beliefs, environmental and socio-economic factors which may promote or otherwise the required action. It also does not factor issues of information asymmetry as it appears to assume that everyone has access to equal amounts of information on risks. Second, it also assumes that health outcome is the main objective in the decision making process. This may not necessarily be the case in the demand for goods for prevention of obesity. For instance, many regular gym users do so for intrinsic motivations which is the enjoyment they get hence utility in use and not necessarily based on the premise that they want to lose weight [2,17,29]. Third, HBM has descriptions of its various constructs but fails to provide explanations or suggestions of strategies with regards to changing health behaviours.

4. The Model

Upon considerations of and factoring the limitations outlined above, the model was developed (Figure 1) using psychological, behavioural economic and standard economic concepts. The model has three essential components – the anchors, anxiety and anxiety driven variables, and action oriented variables and is generally based on Cohen's [12] utility model of prevention.

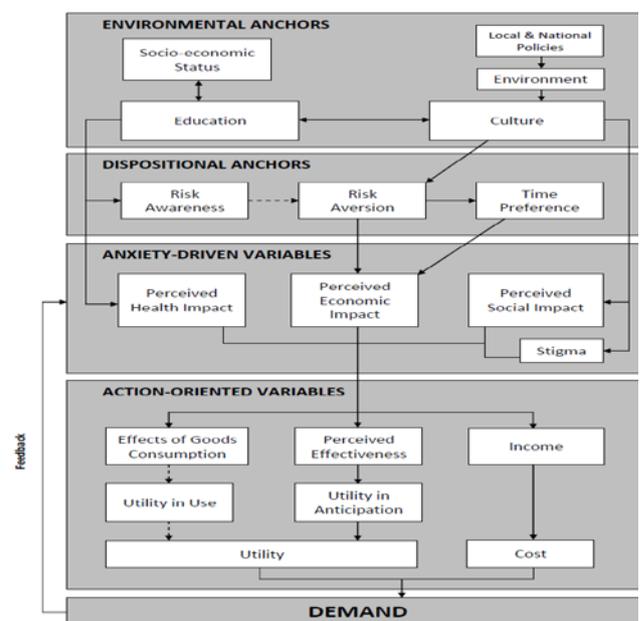


Figure 1. A theory based dynamic model on demand for obesity preventive goods

4.1. The Model Explained

The definitions of the identified variables have been provided in Table 1. This section aims to provide a simple explanation of the logical relationship between the variables.

The correlation between socio-economic status and educational achievements has been well established [63]. Education plays a fundamental role in the behavioural make-up of an individual. It serves as a platform for the individual's understanding of not just their own physical

and health attributes but, most importantly, the environment and culture and the acceptance or otherwise of the cultural factors particularly those that influence weight gain. Education also helps individuals to be aware of risks and helps in their assessments of the risks.

Table 1. Definitions of the identified variables

Category	Variable and explanations
Economic	Utility: As per Bernoulli's Utility Theory, utility is the relative satisfaction/enjoyment an individual gets in consumption[5]. In the case of preventive goods, utility can be derived from both the use value which comes directly with the consumption and the value in anticipation which comes from the awareness that consumption reduces risk. Cohen[12] put these as "utility in use" and "utility in anticipation."
	Time: Not accounting for patient time in healthcare utilisation analysis may lead to exaggerated productivity of the healthcare sector and understate the costs. Patients spend considerable time seeking and receiving health care services which involves opportunity costs. There are also <i>time preference</i> issues in accounting for <i>time</i> as a variable in this equation. The demand for preventive goods is to reduce risks thereby preventing or delaying the onset of the health outcome. When people prefer to delay the onset of the health outcome they are said to have positive time preference. Discounting is a technique widely used to estimate the present value of an input or benefit that is accruing in the future.
	Cost: This includes all monetary costs and not only the cost of the preventive product/service but also the cost of access including travel costs. Therefore cost is in two parts: 1. Price of the good and 2. Costs incurred in consuming the good.
	Income: This may be both at household and individual levels. At household level it can be defined as the combined gross income (consumption and savings opportunity) of all the members of a household who are 18 years of age and older within a specified time frame. At individual level it is the disposable income of the person within the specified period of time. Income is often referred to as the sum of all the wages, salaries, profits, interests payments from various investments, rents and other forms of earnings received in the given time period.
	Perceived economic impact: This is the individual's understanding of the effect of abnormal weight gain on their productivity as well as its financial implications. It is therefore: 1. The worry of the individual of not being able to properly carry out his/her job i.e. decline in productivity 2. The individual's assessment of the burden of purchasing healthcare and for that matter 3. The individual's assessment of savings to be made as a result of the preventive actions.
	Anxiety: In this analysis it does not include the condition called Generalised Anxiety Disorder (GAD) which causes victims to feel anxious about a wide range of situations and issues, rather than one specific event. In this analysis anxiety is the feeling of nervousness, apprehension, fear, or worries of the individual about the consequences (health, social and economic outcomes) of abnormal weight gain.
	Perceived effectiveness/efficacy of the preventive good: This is the individual's understanding of the preventive good's capacity to produce the desired effect.
	Effects associated with the good's consumption (individual): These can be described as the side effects associated with the use of the preventive good from the consumer's perspective. These effects may be personal to the individual or can be external effects. The effects of the use of a product on those who are not involved in the consumption is referred to as externalities.
	Perceived health impact/outcome: This is the individual's understanding of the effect of abnormal weight gain on the length and quality of his or her life.
	Level of education: This is the formal or non-formal level of the individual's educational attainment.
	Socio-economic Status: The individual's position on a scale which measures factors such as profession/occupation, income, education and place/type of residence. These factors to a large extent influence one's lifestyle including attitudes and personality.
Environmental	Culture: For purposes of this analysis culture can be referred to as the ethos which is to a great extent influenced by the environment, ethnicity and religion.
	Environment: Not all individuals may have access to, be able to use, or indeed wish to use recreational facilities such as gyms. However, the vast majority of individuals should be able to walk to local shops and back and also visit the local park.
	Risks associated with the consumed good (environmental)-externalities: The effects of the use of preventive goods may not only be confined to the individual consumer but can affect other people and the environment. The effect of the use of a product on other persons who were not involved in the consumption of the good is commonly referred to as "externalities."
	National policies/programmes (e.g. food production/policies): As in the healthcare industry, food production policies are designed mainly to feed the home population and to export the remainder but also as an ability to intervene where there are market failures. While some are meant to bring about fair distribution of, and access to agricultural products, others have far reaching objectives including the promotion of the production and consumption of locally grown food and/or certain food categories for nutritional purposes. Such policies will therefore not only affect the individual's environment but also the type of food available to him/her.
	Perceived impact on social/community responsibilities: In addition to those family responsibilities and commitments, individuals are expected to participate and contribute to community activities. This is particularly most important for communities where there is that cohesion and spirit of social inclusion (and sense of belonging to the community).
	Stigma: This is the result of negative perception/attribution people have towards an individual whether it is correct or not. In most cases it is condition specific e.g. mental health, physical disability, sexual orientation, or skin colour and often lead to some form of discrimination. Overt deformation, particularly in the case of obesity can often result in severe disapproval or discontent from the society of a person on the basis of his/her obese characteristics that distinguish him/her from the rest of the society.

Cultural influences can at times be significant and includes how people perceive risk and their risk prevention attitudes (i.e. level of risk aversion). In some communities, excess weight is often associated with affluence [34,49]. What is eaten and how it is eaten (food habits) are also greatly influenced by culture [1]. In some cultural settings there is dependence on certain types of food and eating habits are dictated by certain cultural beliefs. High dependence on some of these foods does not only pose balanced diet threats, but are also sources of obesity [4,30]. Religious rules also affect food choices.

Many cultures are shaped around their environments in many respects. Cultures can therefore be seen as means to the adaptation to the environment to a certain extent and these environments have therefore influenced our understanding of ourselves, life and how we interact with it. In the perspective of food production what people grow ordinarily are those that are supported by their natural environment. However, as humans understand this natural environment they have not only devised means of adaptation but taming it for his/her developmental needs. Such a built environment (i.e. the human-made surroundings which provide settings for human activities

including recreational facilities particularly those that support physical exercise), in turn affects health and wellbeing.

These built environments as well as use of the natural environments, what people grow and how they are grown are to very large extent results of local/national policies. The available land for food production is competing not just with the need for settlements but as well the need to preserve the ecosystem and flora and fauna. As a result of these challenges, food and agricultural policies are under scrutiny. The world has witnessed not only the use of chemicals to boost production, but there are increasing policy arguments for the use of gene modification innovations. Some research have in fact observed correlations between the use of chemicals in agricultural activities [19] and incidence of obesity hence the use of the term “obesogens” [27,36].

While it is clear that education puts individuals in positions to be aware of and understand risks; that culture influences one’s level of risk aversion, it is however not necessarily the case that being risk aware makes one risk averse. Some people are generally risk takers not to mention the effects of addiction on the individual. There are also some cultural beliefs that mitigate against risk notwithstanding the fact that they are aware of the risks. Nonetheless, it is likely that one’s level of risk aversion does not only affect his/her preference (time) with regards to both economic/health outcome and their timings, but most essentially his/her anxiety.

Anxiety also anchors on both education and culture. However, the extent of one’s anxiety is driven by a number of variables such as perceived health outcome, perceived economic impact, perceived social impact and stigma. It is anxiety which serves as an impulse to take actions deemed appropriate to address the worries [12].

Nonetheless, taking action depends on income, the perceived effectiveness of the intervention and the effects in the consumption of the good. The latter can affect one’s action positively or negatively. For example some people enjoy going to the gym and to be involved in strenuous exercises. Others who dislike going to the gym let alone to be involved in strenuous exercises will get no enjoyment from the activity. Such positive/negative experiences in the process of taking the good is described as utility in use [12].

With regards to the perceived effectiveness, as in the case of most health interventions, the effects are not necessary instantaneous and it is mainly what the individual anticipates. In that connection the satisfaction gained therein is ultimately in anticipation that the desired objective will be met. Whereas utility in use can be negative, the utility in anticipation can only be positive and must outweigh the former if consumption is to take place. The combination of utility in use and in anticipation results in final utility which is a key economic determinant of demand in the standard economic principles of consumer theory. As in the case of utility, cost is a key factor of demand. However, how much one commits to spend on an intervention at a particular price depends on his/her income level. Where the preventive good demanded fails to satisfy one’s anxiety, the process will then follow a cycle through the feedback effect until the anxiety level eventually diminishes.

5. Conclusions and what next

The analysis of demand for obesity prevention goods is not necessarily fully explained by the principles of standard economic models of consumer behaviour. Instead behavioural economic, psychological and health economic theories will have to be considered to understand people’s preventive behaviours with regards to obesity risk reduction goods.

Anchors serve as decision references and stimulate anxieties which in turn trigger necessary actions. Levels of anxiety are driven by many other factors including concerns for socio-economic, socio-cultural and health outcomes. Notwithstanding this, utility and costs are ultimately crucial variables that influence the determination of demand.

Models are by no means full representations of the complex human behaviours in real life situations. This model demonstrates a possible combination of health economic, neoclassical and behavioural economic principles to explain complex human behaviours with regards to health risk reduction in the context of obesity.

The model needs to be tested and validated by a process of empirical investigation. A robust and well designed questionnaire must be developed for such investigations. It should target three key areas amongst others – the individual’s personal characteristics, socio-economic and cultural background/characteristics, and measuring of the relationships between the concerned variables and how they influence each other. The sample size for the empirical study must be representative of the target population. In this respect since preventive actions will come from normal weight as well as obese individuals, the two populations must be adequately represented in the target population.

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Statement on Competing Interests

I have no conflicts of interest to declare.

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