Understanding consumer receptivity towards foods and non-prescription pills containing phytosterols as a means to offset the risk of cardiovascular disease: an application of protection motivation theory

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Abstract

Consumer purchase intention with respect to foods and non-prescription pills containing phytosterols was investigated through a mall intercept survey ($n = 446$) in Ontario, Canada. The study took as its starting point the Protection Motivation Theory (PMT), a social cognition model rooted in research on fear appeal in determining health-protective behaviour. Structural equation modelling was used to explore whether an adaptation of PMT explains intention to purchase products containing phytosterols as a means to reduce the risk of cardiovascular disease (CVD). The standard form of PMT was adapted to take account of consumer perceptions of the risk of elevated blood cholesterol, reflecting the fact that phytosterols do not directly reduce the risk of CVD but rather help in the management of a single risk factor. Overall, coping appraisal had a positive and significant association with purchase intention, while threat appraisal had no significant effect. Incorporation of cholesterol as a risk factor for CVD significantly improved the measurement strength of the threat appraisal construct. However, the overall predictive power of the model did not change appreciably. The results suggest that the promotion of adaptive behaviours, such as consumption of functional foods and nutraceuticals, needs to focus on perception of response and self-efficacy rather than individual perceptions of risk.

Introduction

Worldwide, cardiovascular disease (CVD) is the leading cause of death and a major cause of disability and lost productivity (Lopez *et al.*, 2006). A multitude of risk factors are associated with CVD, including tobacco smoking, hypertension and diabetes mellitus, with the most important diet-related risk factor being the level and composition of serum cholesterol (American Heart Association, 1998). Indeed, there is compelling evidence that the risk of CVD can be decreased appreciably through the lowering of total and low-density lipoprotein (LDL) cholesterol (Journal of American Medical Association, 2001), with dietary habits being a critical modifiable factor contributing towards this reduction (Keys *et al.*, 1986; Journal of American Medical Association, 2001).

Recently, the role of functional foods and nutraceuticals as a potential means to reduce the risk of certain non-communicable and diet-related diseases has been recognized (see, for example, American Dietetic Association, 2004; Arnoldi, 2004; Institute of Food Technologists, 2005; Rudkowska and Jones, 2007). Diplock *et al.* (1999, p. 16) note:

> A food can be regarded as 'functional' if it is satisfactorily demonstrated to affect beneficially one or more target functions in the body, beyond adequate nutritional effects, in a way that is relevant to either an improved state of health and wellbeing and/or reduction of risk of disease.

Indeed, market sales of functional foods and nutraceuticals have registered significant rates of growth since the late 1990s, such that global sales were estimated at around US$85 billion in 2006 (Nutrition Business Journal, 2007). Of this global total, most sales are in industrialized countries, especially Japan, the US, Europe and Canada.

A notable functional food and nutraceutical innovation associated with reductions in blood cholesterol is the incorporation of plant sterols and stanols (phytosterols) into foods, such as vegetable oil spreads and dairy drinks, and non-prescription pills (Law, 2000; Ntanios, 2001; Rudkowska and Jones, 2007). Phytosterols are chemically similar to cholesterol and, when consumed at adequate levels, can inhibit exogenous and endogenous cholesterol in the gastrointestinal tract (Maki *et al.*, 2003). A number of human clinical trials (see, for example, Weststrate and Meijer, 1998; Hendriks, 1999; Jones *et al.*, 1999; Maki

et al., 2003) have demonstrated that regular consumption of phytosterols can lower total and LDL cholesterol (see reviews by Ling and Jones, 1995; Law, 2000; Rudkowska and Jones, 2007), and thereby decrease the risk of CVD. The report of the US National Cholesterol Education Program Adult Treatment Panel-III enunciates 'therapeutic lifestyle changes' for reducing LDL, in which weight reduction, increased physical activity and reduced intakes of saturated fats are key in the initial stages. In the event that such lifestyle changes are not effective in achieving target LDL levels, the report recommends intake of phytosterols and soluble fibre.

Significant potential public health and economic benefits from consumption of food products and/or non-prescription pills containing phytosterols (see, for example, Malla *et al.*, 2005; Gerber *et al.*, 2006) have been estimated, although the realization of these benefits is dependent on the propensity of consumers to make commensurate changes in their diets. Indeed, the importance of understanding consumer perceptions of functional foods and nutraceuticals, alongside other food technologies, has been recognized (see, for example, Wrick, 1993; Childs and Poryzees, 1997; Gilbert, 2000; Frewer *et al.*, 2003; Verbeke, 2005; Niva, 2007; Blandon *et al.*, 2008; Herath *et al.*, 2008).

A sizeable empirical research literature on consumer attitudes towards functional foods and nutraceuticals has been established (see, for example, Bech-Larsen *et al.*, 2001; Heasman and Melletin, 2001; West *et al.*, 2002; DeJong *et al.*, 2003; Cox *et al.*, 2004; Lucknow and Delehunty, 2004; Urala and Lahteenmaki, 2004; Sorenson and Bogue, 2005; Verbeke, 2005; Henson *et al.*, 2008). Existing studies suggest that belief in the efficacy of functional ingredients plays a critical role in determining the propensity to consume. However, there is also evidence that, aside from perceived efficacy, the mode through which functional ingredients are delivered mitigates consumer acceptability (DeJong *et al.*, 2003; Wennstrom and Mellentin, 2003; Henson *et al.*, 2008), in part because of variation in perceptions of the ability to use such products effectively (Cox *et al.*, 2004). It is evident, however, that more research is needed on the propensity of consumers to use functional foods and nutraceuticals as part of broader strategies towards health-related dietary change and how this varies across functional ingredients. Here, we focus specifically on the use of phytosterols and relations with perceptions of impacts on levels of blood cholesterol and, in turn, the personal risk of CVD. More generally, the results address the paucity of studies on consumer acceptance of functional foods and nutraceuticals in Canada (with the notable exceptions of West *et al.*, 2002; Labrecque *et al.*, 2006; Malla *et al.*, 2005; Henson *et al.*, 2008), recognizing that attitudes towards such products tend to be culture specific (Bech-Larsen *et al.*, 2001; Labrecque *et al.*, 2006).

Modelling consumer propensity to consume food products and non-prescription pills containing phytosterols

Several behavioural theories from social psychology have been used to understand the propensity of individuals to take actions towards health improvement (Armitage and Conner, 2000).[1] Broadly, all of these approaches recognize that the motivation for health protection results from perceived threat and the desire to avoid the associated potential negative outcomes, and that the response of individuals reflects a balancing of the costs and benefits of alternative courses of action (Floyd *et al.*, 2000). Comparing the results of empirical studies using these alternative paradigms is, however, plagued by data problems (Weinstein, 1993, 2007).

The theoretical underpinning of the current study is Protection Motivation Theory (PMT), a social cognition model rooted in research on fear appeal in determining health-protective behaviour (Rogers, 1975; Maddux and Rogers, 1983). PMT has been widely applied in health psychology research (see, for example, Rippetoe and Rogers, 1987; Plotnikoff and Higgingbotham, 1995, 1998; Orbell and Sheeran, 1998; Palardy *et al.*, 1998; Floyd *et al.*, 2000; Milne *et al.*, 2000; Ruiter *et al.*, 2003). It has been shown to have good predictive power in the case of health-related dietary change (see, for example, Plotnikoff and Higgingbotham, 1995, 1998; Cranfield *et al.*, 2007) and specifically, with respect to the use of functional foods and nutraceuticals (Cox *et al.*, 2004; Cox and Bastiaans, 2007; Henson *et al.*, 2008).

According to PMT, health-related behaviour results from expected consequences and perceived value, while significant differences exist in perceptions of the ability to influence or control own health across individuals. When faced with a potential threat, an individual first assesses whether that threat applies to them (*threat appraisal*) and then considers alternative preventive behaviours (*coping appraisal*) (Tanner *et al.*, 1989, 1991; Weinstein *et al.*, 1998; Neuwirth *et al.*, 2000) (Fig. 1). Although protection motivation is latent, and so not directly observable, it is indexed by behavioural intention, which is considered a reasonable predictor of behaviour (Ajzen, 1988).

Threat appraisal is the process whereby an individual evaluates the factors that increase or decrease the incentives to take protective actions in the form of behavioural change against a health threat. These behaviours may vary, including changing existing behaviours and/or adopting new ones, according to the nature of the threat, the individual's *vulnerability* to it, and the intrinsic and extrinsic rewards associated with the change in behaviour that closely reflect the *severity* of the disease (Neuwirth *et al.*, 2000). Thus, before changing their behaviour, an individual must conclude that the specific hazard directly affects them and that the effects of the hazard outweigh the benefits of continuing with existing 'undesirable' behaviour.

The perceived threat of the disease stimulates the individual to take coping strategies in order to protect himself/herself from this

[1]Examples include the Health Belief Model (see, for example, Becker *et al.*, 1977; Aho, 1979; O'Connell *et al.*, 1985; Schafer *et al.*, 1995; Sapp and Jensen, 1998; Kloeblen and Batish, 1999; Nejad *et al.*, 2005; Sapp and Weng, 2007), Transtheoretical Model (see, for example, Greene *et al.*, 1999; Howarth, 1999; Burke *et al.*, 2000; Littell and Girvin, 2002; Frenn and Malin, 2003; Clark *et al.*, 2005;Chung *et al.*, 2006; De Vet *et al.*, 2006; Lea *et al.*, 2006; Shepherd, 2006), Social Cognitive Theory (see, for example, Miller *et al.*, 1999; Reynolds *et al.*, 1999; Anderson *et al.*, 2000, 2007; Rinderknecht and Smith, 2004) and Theory of Reasoned Action/Theory of Planned Behaviour (see, for example, Armitage and Conner, 1999; Leek *et al.*, 2000; Sparks *et al.*, 2001; Olsen, 2001; Chase *et al.*, 2003; Lytle *et al.*, 2003; Nejad *et al.*, 2005; Verbeke and Vackier, 2005; Fila and Smith, 2006).

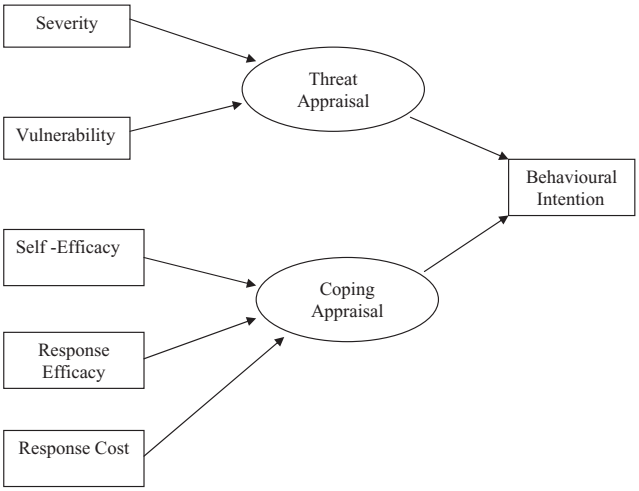

Figure 1 Major cognitive components of the Protection Motivation Theory.

threat. This coping appraisal process consists of three simultaneous actions: (1) a belief that the preventive behaviour will work (*response efficacy*); (2) an assessment of self-ability to cope with the threat, initiate change from the risky behaviour and complete the adaptive behaviour (*self-efficacy*); and (3) an estimation of the costs associated with the consequent behavioural change (*response cost*) (Gardner and Stern, 1996; Rogers and Prentice-Dunn, 1997). Response efficacy and self-efficacy tend to increase the likelihood of making a behavioural change, while the associated financial cost, and/or time and effort reduces the probability of reacting to a hazard. The relationship between these three elements of coping appraisal is generally considered to be linear and additive (Rogers, 1983).

PMT suggests that an individual confronted with the potential risk of CVD will first assess their own threat based on their awareness and knowledge, current health state and perceived vulnerability. Key here might be the extent to which there is a history of heart health problems in the individual's family. A perceived threat will only lead to behavioural change, however, if the individual believes that they are able to cope with that threat. Causes of continuing maladaptive behaviour can include feelings of defensiveness, hopelessness and/or fatalism, social context or the demand for immediacy of reward (Rogers and Prentice-Dunn, 1997). Consumers may also lack knowledge of potential adaptive behaviours. Having decided to make a behavioural change, the individual must be convinced that the potential course of action will curtail their risk of CVD and/or the severity of effects (*response efficacy*), and that they will be able to follow through with those actions (*self-efficacy*). The combination of a high threat appraisal and high coping appraisal translates into higher protection motivation.

The particular focus of the current study is the propensity of consumers to take actions aimed at mitigating blood cholesterol as a key risk factor for CVD. Although the end result and the rationale for such behaviour is a reduction in the risk of CVD, a variety of other factors might mitigate the change in risk at the level of the individual, whether related to their genetic disposition or because of offsetting behaviour (for example, reductions in levels of physical exercise and/or increases in levels of tobacco use). This is a quite different context to most other applications of PMT and requires adaptation of the core PMT model. Thus, we incorporate an additional *cholesterol risk* component into the threat appraisal construct that assesses perceptions of the extent to which the single risk factor (blood cholesterol) is associated with the risk of contracting the disease (CVD). The rationale behind this is that the consumer is unlikely to take a protective action against elevated blood cholesterol, regardless of how great the threat they perceive from CVD, unless they consider blood cholesterol to have a strong association with the perceived vulnerability and/or severity of CVD that they face.

At the same time that blood cholesterol is a risk factor for CVD, it also acts as a 'biomarker' of the threat to the individual (McClure, 2002; Senior and Marteau, 2007). A priori, this might suggest that, in the context of CVD, the risk factor component is likely to be a major determinant of the threat appraisal construct. However, evidence that biomarker feedback increases the motivation to change behaviour tends to be quite weak (see, for example, McClure, 2002). In the case of blood cholesterol specifically, while some studies indicate that individuals provided with information on their cholesterol risk profile exhibit a greater intent to make dietary changes compared with control groups (Gemson *et al.*, 1990; Aubin *et al.*, 1998), other studies report that consumers with or without their cholesterol risk profile are equally likely to change their dietary behaviour in response to nutrition information (Strychar *et al.*, 1998). Further, Robertson *et al.* (1992) and Elton *et al.* (1994) find that providing information on blood cholesterol levels does not significantly lower measurements of post-test cholesterol levels relative to individuals that do not receive such information.

Methods

The data collection instrument was designed to investigate the propensity of consumers to consume a range of functional ingredients in the form of foods and/or prescription pills, guided by previous literature on the application of PMT to health-related dietary change (Plotnikoff and Higginbottam, 1995, 1998, 2002; Bennett *et al.*, 1998; Milne and Orbell, 2000). The instrument took the form of a structured self-completion questionnaire that included items to capture the theoretical constructs of PMT, including the additional risk factor construct described above. The phrasing of questions and some wider attitudinal elements of the instrument were designed on the basis of a series of four focus groups held over the period of March 2006 to April 2006 in Guelph, Ontario, Canada. The initial version of the questionnaire was pre-tested with 10 recruited consumers, and based on their feedback, a revised and final version was prepared.

The questionnaire was elicited in a shopping mall in Guelph, Ontario, during February 2008. Potential respondents were approached at random and asked if they would be willing to participate in the study. Quotas were applied to the composition of the sample on the basis of age and gender according to the 2001 Canadian census. A total of 446 respondents were surveyed aged 18 years and over. The sample was approximately representative of the Canadian population across most key demographic characteristics (Table 1), with the exception of the 55 years and older age

Table 1 Characteristics of the study sample compared with the Canadian population

Characteristics	Sample survey ($n = 446$) *n* (%)	Canadian population %
Gender		
Male	221 (49.6)	48.9
Female	225 (50.4)	51.0
Age		
18–34	144 (32.3)	26.0
35–54	115 (25.8)	31.0
55 and over	187 (42.0)	25.3
Education		
Some grade school	28 (6.7)	N/A
Some high school/high school graduate	91 (20.9)	23.0
Some university/college	116 (23.3)	13.4
University/college graduate	147 (32.8)	25.6
Postgraduate	84 (16.3)	4.8
Total household income		
Under $35 000	109 (24.4)	19.7
Above $35 000 and below $75 000	180 (40.4)	41.5
Above $75 000 and below $119 000	96 (21.6)	24.0*
Equal or above $120 000	61 (13.6)	14.7**

N/A, not applicable.

Note: Information sources for Canadian population as follows:
Gender (2005): Statistics Canada CANSIM II Table 1095315
Age (2006): Statistics Canada 2006 Census
Education (2006): Statistics Canada 2006 Census
Total household Income (2006): Statistics Canada 2006 Census (Note: *above $75 000 and below $125 000; **$125 000 and above).

group, and individuals with 'some university/college', both of which were oversampled.

Construction of scales for measurement of PMT variables

Multi-item scales were used to derive measures for each of the PMT model constructs, including the additional cholesterol risk factor construct. In each case, seven-point Likert scales were used to elicit responses. The specific items associated with each construct, their mean values and standard deviation (SD), and the Cronbach alpha coefficients of item reliability are reported in Tables 2 and 3.

Perception of the severity of CVD was captured using five statements where the response options ranged from 'completely agree' (7) to 'completely disagree' (1). These statements captured the perceived impact of CVD on the respondent's quality of life, career and financial status (Milne and Orbell, 2000). The Cronbach alpha ($\alpha = 0.84$) indicates that the summated scale is a reliable measure. With an average summated scale score of 4.81 (SD = 1.48), the sample as a whole clearly considered CVD to be relatively severe.

The degree of perceived vulnerability to CVD was assessed using four statements. The first two statements, 'the risk of heart disease worries me a lot' and 'I know many people who have suffered from heart disease', were elicited using a scale from 'completely agree' (7) to 'completely disagree' (1). Two other statements solicited judgements of own risk of CVD compared with the average adult in the Canadian population using a scale ranging from 'extremely high' (7) to 'extremely low' (1). Recognizing the need to differentiate the risk perceptions of respondents who had already been diagnosed with CVD from those that had not been diagnosed, the statements were phrased differently for each subgroup (see part I and part II under the vulnerability construct in Table 2). Overall, the multi-item scale measuring the vulnerability construct had acceptable reliability ($\alpha = 0.59$) that is broadly comparable to previous studies (for example, Plotnikoff and Higginbotham, 1995). The sample average of the summated scale (3.71; SD = 1.32) suggested that the overall level of perceived vulnerability was low, especially relative to perceived severity.

The additional construct to incorporate perceptions of cholesterol as a risk factor for CVD (*cholesterol risk*) was based on a three-item scale. The first two statements, 'failure to control your blood cholesterol puts you at a greater risk of getting heart disease' and 'blood cholesterol is a major factor for heart disease', were scored on a scale ranging from 'completely agree' (7) to 'completely disagree' (1). The third statement judged respondent's perception of the importance of controlling blood cholesterol in determining his/her own risk of developing CVD from 'extremely important' (7) to 'extremely unimportant' (1). The reliability of the multi-item scale was very good ($\alpha = 0.84$). The mean value of the scale was high at 5.71 (SD = 1.11), suggesting strong perceptions that cholesterol is a risk factor for CVD.

The concurrent validity of the summated scale for cholesterol risk was assessed by comparing the mean value of respondents according to their serum cholesterol testing. It was hypothesized that respondents who had not recently had their blood cholesterol tested (specifically, in the last 6 years) (group 1) would perceive a weaker association between blood cholesterol and the risk of CVD compared with respondents who had recently had their blood cholesterol tested (specifically, in the last 2 years) (group 2). This was confirmed by the average values of the summated scales for cholesterol risk, which were 5.24 (SD = 0.85) for group 2 and 4.96 (SD = 0.96) for group 1. This difference was statistically significant ($P = 0.005$) and suggests that the cholesterol risk construct indeed exhibited concurrent validity.

The response efficacy of consuming food products and non-prescription pills containing phytosterols as a means to control blood cholesterol was captured through perceptions of the effectiveness of four alternative products (namely, a non-prescription pill, margarine, low-fat milk and bread) on a scale from 'completely agree' (7) to 'completely disagree' (1) (Table 3). The sample average of the perceived effectiveness of bread containing phytosterols at controlling blood cholesterol (4.63; SD = 1.89) was significantly ($P < 0.000$) higher than for the non-prescription pill (4.13; SD = 1.97) and margarine (4.20; SD = 1.95), but not significantly different from the low-fat milk (4.57; SD = 1.95). The average of the perceived effectiveness of these four modes of delivery was used as a construct representing the response efficacy of phytosterols overall. The reliability of the multi-item scale for response efficacy of phytosterols was very good ($\alpha = 0.87$). The average value of the multi-item scale was 4.38 (SD = 1.63).

Table 2 Basic statistics on threat appraisal constructs for path model

Threat appraisal constructs/items	Mean	SD
Severity (completely agree = 7; completely disagree = 1)		
My quality of life would be severely affected by heart disease	5.81	1.30
Having heart disease would seriously affect my career	4.46	2.14
Having heart disease would reduce my quality of life significantly	5.30	1.71
Having heart disease would seriously affect my financial situation	4.40	2.01
Having heart disease would slow/halt my career advancement		
Summated scale for severity ($\alpha = 0.8345$)	4.81	1.48
Vulnerability		
The risk of heart disease worries me a lot (completely agree = 7; completely disagree = 1)	3.44	1.80
I know many people who have suffered from heart diseases (completely agree = 7; completely disagree = 1)	4.09	1.95
For respondents who has not been diagnosed with heart diseases		
Compared with the average adult Canadian of my gender, my risk of developing heart disease is . . . (extremely high = 7; extremely low = 1)	3.68	1.61
I believe that the likelihood that I will have heart disease in the future is . . . (extremely high = 7; extremely low = 1)	3.51	1.53
For respondents who has been diagnosed with heart diseases		
Looking back to the time before the diagnosis, please recall your perception of your risk of developing heart disease when compared with the average adult Canadian of your gender. Was this . . . (extremely high = 7; extremely low = 1)	4.08	1.80
Again, looking back to that time, please recall your belief of the likelihood that you would have heart disease in the future. Was this . . . (extremely high = 7; extremely low = 1)	4.2	1.93
Summated scale for vulnerability ($\alpha = 0.5911$)	3.71	1.32
Cholesterol risk		
Failure to control your blood cholesterol puts you at greater risk of getting heart disease (completely agree = 7; completely disagree = 1)	5.65	1.46
Blood cholesterol is a major risk factor for heart diseases (completely agree = 7; completely disagree = 1)	5.33	1.49
Importance of controlling blood cholesterol in determining own risk of developing heart disease (extremely important = 7; extremely unimportant = 1)	6.13	1.17
Summated scale for cholesterol risk ($\alpha = 0.8378$)	5.71	1.11

SD, standard deviation.

Table 3 Basic statistics on coping appraisal constructs for path model

Coping appraisal	Mean	SD
Response efficacy		
Following products are effective ways to reduce blood cholesterol for you personally (completely agree = 7; completely disagree = 1)		
A non-prescription pill containing phytosterols	4.13	1.97
Margarine containing phytosterols	4.20	1.95
Low-fat milk containing phytosterols	4.57	1.95
Bread containing phytosterols	4.63	1.82
Summated scale for response efficacy ($\alpha = 0.8680$)	4.38	1.63
Self-efficacy		
How confident are you personally in your ability and inclination to consume the recommended quantities of each of the following products to reduce your own blood cholesterol effectively (extremely confident = 7; extremely unconfident = 1)		
A non-prescription pill containing phytosterols	3.85	2.09
Margarine containing phytosterols	4.09	2.12
Low-fat milk containing phytosterols	4.39	2.10
Bread containing phytosterols	4.51	1.99
Summated scale for self-efficacy ($\alpha = 0.8740$)	4.19	1.76

SD, standard deviation.

The self-efficacy of consuming each of the four phytosterol-containing products was assessed through a single item for each, 'please tell me how confident are you personally in your ability to consume the recommended quantities of each of the following products to reduce your own blood cholesterol effectively', using a scale from 'extremely confident' (7) to 'extremely unconfident' (1). Overall, respondents were least confident in their ability to use the non-prescription pill (3.85; SD = 2.09) and most confident in

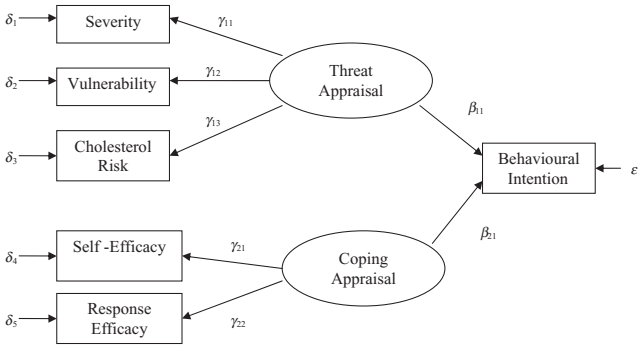

Figure 2 Path diagram of the structural equation model of the Protection Motivation Theory constructs.

the self-efficacy of bread (4.51; SD = 1.99). As with response efficacy, a single measure of self-efficacy was derived by taking the average value of perceived self-efficacy across the four modes of delivery. The reliability of the multi-item scale for self-efficacy was very good ($\alpha = 0.87$). The average value of the multi-item scale was 4.19 (SD = 1.76).

Behavioural intention in terms of consumption of each of the four phytosterol-containing products was evaluated through a single item, 'please tell me how likely you would be to purchase the product to reduce your own level of blood cholesterol', using a scale from 'very likely' (7) to 'very unlikely' (1). A single measure of behavioural intention was constructed from the average across the four modes of delivery. The reliability of the multi-item scale was very good ($\alpha = 0.84$). The average value of the multi-item scale was 3.94 (SD = 1.79).

Results

Following the standard form of PMT, behavioural intention was modelled as a linear function of the threat appraisal and coping appraisal latent constructs (Fig. 2). Specifically, structural equation modelling was used to capture linear relationships between the latent constructs and the relevant reflective indicators: between threat appraisal and the indicators' perceived severity, perceived vulnerability and perceived cholesterol risk, and between coping appraisal and the indicators' perceived response efficacy and perceived self-efficacy. The two latent constructs were hypothesized to be linearly related to the formative indicator of purchase intention. The model was estimated using LISREL 8.8 version (Scientific Software International, Inc. Lincolnwood, IL, US) (Joreskog and Sorbon, 1999). The errors of the measurement models capturing directional association between the reflective indicators and the latent threat and coping appraisal constructs were designated as δs. The error of the structural model linking threat and coping appraisal with behavioural intention were designated as ε (Fig. 2).

PMT was first applied to the intention to purchase food products and/or non-prescription pills containing phytosterols as a means to manage blood cholesterol in its standard form (i.e. without the cholesterol risk construct) (model I). Subsequently, cholesterol risk was introduced as an additional formative variable on the threat appraisal latent construct (model II). The results for these two models are reported in Table 4.

The overall fit of model I is impressive [$\chi^2 = 4.19$; degrees of freedom (df) = 3; $P = 0.24$; root mean square error of approximation (RMSEA) = 0.030]; a RMSEA below 0.05 is indicative of acceptable fit of the data (Diamantopoulos and Siguaw, 2000). In model II, the overall model fit was acceptable, although the introduction of the cholesterol risk construct did not provide an appreciable improvement ($\chi^2 = 11.65$; $df = 7$; $P = 0.11$; RMSEA = 0.039). The 90% confidence interval for RMSEA (0.0–0.09) was clearly within the acceptable region (Diamantopoulos and Siguaw, 2000). Further, the strength of the positive associations between the threat appraisal construct and the severity and vulnerability constructs was significantly greater.

Testing the measurement model: threat appraisal

The measurement model between threat appraisal and the severity and vulnerability formative variables in model I revealed substantial measurement errors. As indicated by the *R*-square values, only 9% of variation in the severity construct and 21% of variation in the vulnerability construct were explained by the threat appraisal latent variable. Despite such measurement errors, *t*-values for the threat appraisal latent construct were significant ($P < 0.000$) for both the severity and vulnerability constructs, suggesting that these formative variables are appropriate. As expected, the cholesterol risk construct had a pronounced directional linkage with the threat appraisal latent construct. In model II, around 52% of variability in cholesterol risk was explained by threat appraisal. The incorporation of the cholesterol risk construct also led to improved convergent validity in terms of *t*-values and *R*-square values for both the severity (*R*-square increased from 0.09 to 0.15) and vulnerability (*R*-square increased from 0.21 to 0.29) variables (Table 4). As indicated by the standardized coefficients, among the three formative variables for threat appraisal, cholesterol risk had the greatest impact (0.86) and was the strongest predictor.

The composite (construct) reliability[2] of the three individual formative indicators in measuring the threat appraisal latent construct was calculated based on the completely standardized LISREL solution (Diamantopoulos and Siguaw, 2000). It is suggested in the literature that a composite reliability (ρ_c) value exceeding 0.6 is desirable (Bagozzi and Yi, 1988). In model II, the ρ_c value for the threat appraisal construct was 0.52, suggesting that the three formative variables provided an acceptable level of composite reliability.

Testing the measurement model: coping appraisal

In model I, the level of measurement errors in the relationships between the latent coping appraisal variable and associated formative variables for self-efficacy and response efficacy were much lower than for threat appraisal, with *R*-square values of 0.73 and

[2] $$\rho_c = \frac{\left(\sum \lambda\right)^2}{\left[\left(\sum \lambda\right)^2 + \sum \theta\right]}$$

where ρ_c = composite reliability, λ = formative indicator loading and θ = formative indicator error variance.

Table 4 Estimates of path coefficients for the Protection Motivation Theory model

Model/variable	Label	Coefficient (*t*-value)	Standardized coefficient	R^2	Label	Coefficient (*t*-value)	Standardized coefficient	R^2
	Model I (without cholesterol risk)				Model II (with cholesterol risk)			
Threat appraisal								
Severity	γ_{11}	0.48 (4.13***)	0.26	0.09	γ_{11}	0.59 (6.37***)	0.33	0.15
Vulnerability	γ_{12}	0.62 (4.70***)	0.41	0.21	γ_{12}	0.73 (8.51***)	0.52	0.29
Cholesterol risk	–	–	–	–	γ_{13}	0.86 (10.80***)	0.67	0.52
Coping appraisal								
Self-efficacy	γ_{21}	1.52 (21.17***)	0.85	0.73	γ_{21}	1.52 (17.74***)	0.89	0.72
Response efficacy	γ_{22}	1.41 (21.11***)	0.85	0.73	γ_{22}	1.41 (21.29***)	0.85	0.73
	Model I – structural relationships				Model II – structural relationships			
Threat appraisal	β_{11}	–0.11 (–0.55)	–0.005	0.76	β_{11}	–0.068 (–0.77)	–0.07	0.76
Coping appraisal	β_{21}	1.65 (10.41***)	0.77		β_{21}	1.61 (18.23***)	0.87	

The asterisks (***) indicate statistically significant at the 1% level.

0.73 respectively (Table 4). The incorporation of the cholesterol risk construct did not improve the directional linkages between coping appraisal, self-efficacy and response efficacy. Indeed, the values of the standardized coefficients for self-efficacy and response efficacy were very similar across models I and II.

As in many other applications of PMT to health protection behaviour (see, for example, Floyd *et al.*, 2000; Milne *et al.*, 2000), the self-efficacy construct had the greatest impact on the coping appraisal latent variable, with a standardized coefficient of 0.85 in model I and 0.85 in model II. The composite (construct) reliability measure of ρ_c for the two formative indicators in measuring coping appraisal was 0.78, suggesting much better composite construct reliability than for the threat appraisal construct.

Testing the structural model

As previously noted, many of the overall fit indices for model II suggested appreciable correspondence between the suggested theoretical model and the empirical data (Goodness of Fit = 0.97; Normed Fit Index = 0.96; critical N = 920; standardized Root Mean Square Residual = 0.028) (Bagozzi and Yi, 1988). Around 76% of the variation in purchase intention was explained by the threat and coping appraisal constructs. Unexpectedly, however, threat appraisal had a negative association with the intention to purchase foods and/or non-prescription pills containing phytosterols in both model I and model II, although the coefficients were not statistically significant. As indicated by the standardized coefficients, the negative impact of threat appraisal (–0.03) on behavioural intention was much smaller than the positive impact of coping appraisal (0.88). Further, the *t*-value for coping appraisal in explaining behavioural intention was significant ($P < 0.000$) and had a much larger impact than threat appraisal in both model I and model II. These results are broadly comparable to previous studies using PMT; meta-analyses of such studies by Floyd *et al.* (2000) and Milne *et al.* (2000) indicate that the threat appraisal construct generally has weaker predictive capacity and a smaller impact on behavioural intention than the coping appraisal construct.

Conclusions

The research results reported above contribute to the growing body of studies that use PMT in order to understand the propensity of consumers to undertake health-related dietary change. Further, it fills a specific gap in the literature relating to use of functional foods and nutraceuticals. Although existing research suggests that consumers may be receptive to the consumption of foods and/or non-prescription pills containing functional ingredients, the majority of studies have not related behavioural intentions to efforts that offset specific health risks (notable exceptions include Cox *et al.*, 2004; Cox and Bastiaans, 2007; Henson *et al.*, 2008). The results confirm that the PMT framework can indeed throw considerable light on the propensity of consumers to undertake health-related dietary changes in general and to consume functional foods and nutraceuticals specifically.

As with prior studies on health-related dietary change more broadly, the results suggest that response efficacy and self-efficacy are key drivers of the intention to consume foods and/or non-prescription pills containing phytosterols as a means to reduce the risk of CVD. Thus, as we might expect, consumers are more likely to use such products if they perceive that they work and that they are able to consume such products in the manner that is required in order to be efficacious. At the same time, however, perceptions of the personal threat of CVD do not appear to have an appreciable impact on behavioural intention. Individuals with a low perceived threat of CVD are as likely to indicate a high willingness to consume products containing phytosterols as individuals with a high perceived threat. Taken as a whole, these results suggest that consumers with a high response efficacy are most likely to use products containing phytosterols, regardless of the degree to which they perceive themselves to be at threat from CVD.

Unexpectedly, the inclusion in the analysis of cholesterol as a risk factor for CVD has no appreciable impact on the intention to purchase food and/or non-prescription pills containing phytosterols. This reflects the more general observation that threat appraisal is not a significant driver of behavioural intention. However, at the same time, it suggests that biomarkers, such as

blood cholesterol, that provide a more visible and measurable indicator of risk do not have an appreciable impact on the propensity to undertake adaptive behaviours, in this case, consuming products containing functional ingredients. Alongside the existing literature, these results raise doubts over the extent to which biomarkers more broadly are effective at inducing behavioural change.

The results have significant implications for the promotion of functional foods and nutraceuticals as a part of broader strategies to reduce the incidence of CVD and other non-communicable diseases. A focus on highlighting personal risk of CVD is unlikely to have much success at stimulating consumers to undertake adaptive behaviour. Rather, communication efforts need to focus on evidence that products containing functional ingredients actually reduce personal risk (however great or small that risk might be) and can easily be used in a manner that is efficacious. Such efforts can be undertaken at the population level, with little appreciable benefit being evident from targeting high-risk individuals and/or that high-risk individuals require distinct messaging. At the same time, attention needs to be given to the type and form of products in which functional ingredients are delivered; consumers must be presented with these ingredients in a manner that they perceived to be easy to use, such that the desired level of the functional ingredient is delivered. The results suggest that the perceived effectiveness of phytosterols differs appreciably according to the product in which they are incorporated. The 'bottom line' is that functional ingredients must not only be perceived to work, but be delivered in a form that consumers consider appropriate.

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