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Difficulty of healthy eating: A Rasch model approach

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ABSTRACT

This study aims to measure the difficulty of healthy eating as a single latent construct and, within that, assess which dietary guidelines consumers find more or less difficult to comply with using the Rasch model approach. Participants self-reported their compliance with 12 health-promoting dietary recommendations related to cooking methods and consumption of specific food items. Data were drawn from a survey elicited using a longitudinal consumer panel established in the City of Guelph, Ontario, Canada in 2008. The panel consists of 1962 randomly-selected residents of Guelph between the age of 20 and 69 years. The response rate was equal to 68 percent. The main assumptions of the Rasch model were satisfied. However, subsequent differential item functioning analysis revealed significant scale variations by gender, education, age and household income, which reduced the validity of the Rasch scale. Conversely, these scale variations highlight the importance of socio-economic and demographic factors on the difficulty of healthy eating.

Introduction

The increasing prevalence of non-communicable chronic diseases in industrialized countries, for example cardiovascular disease, stroke, type-2 diabetes and various cancers, has raised serious concerns about the associated economic and social costs, both in terms of the resources required for medical treatment and the wider economic and social losses associated with escalating rates of morbidity and premature mortality (Cash, Goddard, & Lerohl, 2006; Malla, Hobbs, & Perger, 2007). The incidence of these diseases, and the associated costs, are also rapidly increasing in emerging economies (Potkin, Kim, Rusev, Du, & Zizza, 2006). Thus, non-communicable chronic diseases worldwide are increasingly seen as both a public health and an economic issue (Cash et al., 2006).

Numerous studies suggest that the incidence of key non-communicable chronic diseases are heavily associated with lifestyle, and predominantly dietary factors and physical inactivity (see for example Geleijnse, Kok, & Grobbee, 2004; Katzmarzyk & Janssen, 2004; Meng, Maskarinec, Lee, & Kolonel, 1999; Potkin et al., 2006; Robertson, Bound, & Segal, 1998). Thus, particular attention has been focused on how to bring about significant and persistent changes in dietary behavior (Brownson, Haire-Joshu, & Luke, 2006; Darnton-Hill, Nishida, & James, 2004). Science-based dietary guidelines have been established by a number of industrialized countries (see for example DHHS & USDA, 2005; Health Canada, 2007) and internationally by the World Health Organization (WHO) (WHO, 2004) in order to provide guidance to consumers on the composition of a healthy diet. It is recognized, however, that many consumers struggle to align their diets with these recommendations (Blaylock, Smallwood, Kassel, Variyam, & Aldrich, 1999; Kumanyika et al., 2000; Pronk et al., 2004; Shepherd, 2006; Srinivasan, 2007). Indeed, for many consumers compliance with dietary guidelines implies significant reductions in the intake of fats, simple sugars and salt, and increases in the intake of dietary fiber and fruits and vegetables, which translates into profound changes in food consumption patterns (Putnam, Allshouse, & Kantor, 2002; Srinivasan, 2007).

Clearly, the food choices made by consumers are influenced by a wide range of economic, psychological and social factors, and it is in this context that dietary recommendations and other food and/or health-related information influence what consumers choose to eat (Conner & Armitage, 2006; De Boer, Hoogland, & Boersema, 2007; Divine & Lepisto, 2005; Köster, 2009; Miljkovic, Nganje, & de Chastenet, 2008). The use of psychology-theoretical approaches has thrown considerable light on the key drivers of attempts by consumers to eat a healthy diet (Adams & Mowen, 2005; Baranowski, Cullen, & Baranowski, 1999; Conner, Norman, & Bell, 2002; Sullivan & Rothman, 2008; Wardle, 2006). However, we need to understand better the wide range of factors that make it difficult for consumers to eat healthily if we want to reduce the gap between dietary recommendations and consumer dietary behavior. While socio-economic and demographic characteristics have been

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considered predominant factors (for example gender, age, income and education) (Ball & Crawford, 2005; Beydoun & Wang, 2008; Ricciuto, Tarasuk, & Yatchew, 2006) there is a need to recognize the complex interplay of factors that influence what people choose to eat (Birch, 1999; Blaylock et al., 1999; Conner & Armitage, 2006; De Boer et.al., 2007; Köster, 2009; Rozin, 2006) and the mitigating role of attitudes towards food, diet and health, genetic predisposition, etc. (Miljkovic et al., 2008; Sclafani, 2001).

Consumer awareness of dietary guidelines can positively influence healthy eating. Indeed, empirical studies suggest that better informed consumers are more likely to adopt healthier diets. For example, significant relationships have been found between nutrition knowledge and recommended fruit, vegetable and fat intake (Wardle, Parmenter, & Waller, 2000); nutrition awareness and nutrition related-behaviors (Van Dillen, Hiddink, Koelen, de Graaf, & Woerkum, 2007); knowledge of dietary guidelines and fruit and vegetable, dairy product and whole grain consumption (Kolodinsky, Harvey-Berino, Berlin, Johnson, & Reynolds, 2007); consumer knowledge and whole grain food consumption (Lin & Yen, 2008; Mancino, Kuchler, & Leibtag, 2008); and dietary knowledge and reduction of beef and pork consumption (Yen, Lin, & Davis, 2008).

While previous studies support the notion that consumer awareness of dietary guidelines positively influences healthy eating, it is recognized that awareness is not a sufficient condition to comply with dietary guidelines (Blaylock et al., 1999). Pollard, Miller, Woodman, Meng, and Binns (2009), for example, report that while knowledge of recommended fruit and vegetable consumption in Australia increased from 1995 to 2004, this change in knowledge did not result in significant increases in consumption. Further, Variyam & Blaylock (1998) suggest that, while most US consumers are able to identify foods with high levels of fat, fiber and/or cholesterol, specific knowledge on dietary recommendations tends to be more limited (Hendrie, Coveney, & Cox, 2008; Keenan, AbuSabha, & Robinson, 2002).

The studies reviewed above illustrate the multiple factors that influence consumer compliance with health-related dietary recommendations. However, much of this work has tended to focus on the ability of consumers to comply with dietary recommendations in a rather general way or focuses on compliance with recommendations on a piece-by-piece basis (for example reductions in fat or salt intake). Indeed, most empirical studies examine on quite specific aspects of diet, for example consumption of fruits and vegetables (Pollard et al., 2009), whole grains (Mancino et al., 2008) and meat and fats (Yen et al., 2008), which makes it difficult to compare the difficulty of adherence across dietary recommendations and to measure the problems encountered in healthy eating overall. Indeed, there appears to have been little attempt to compare the ease or difficulty of meeting individual dietary recommendations in a consistent manner and how as a collective these behaviors constitute a single construct of the difficulty of healthy eating.

The aim of this study is to measure the difficulty of healthy eating as a single latent construct and, within that, to assess which dietary guidelines consumers find more or less difficult to meet. Specifically, we evaluate the difficulty faced by consumers in complying with 12 dietary recommendations using a Rasch modeling approach (Bond & Fox, 2007; Fox & Jones, 1998; Rasch, 1960). In the next section we introduce the Rasch model, followed by methods, results, discussions and conclusions.

Rasch model

The Rasch model measures the relationship between a person's ability and an item difficulty, and models this as a probabilistic function. Specifically, raw data from a rating scale is converted to "an equal interval scale" measured in logits (log odd units), reflecting the item difficulty and person's ability (Bond & Fox, 2007; Fox & Jones, 1998). In the case of a Likert response scale, the probability (p) that a person (n) with an ability (β_n) to abide by a dietary recommendation (i) at any given scale level *(k),* with a level of difficulty (τ_k) and overall behavior difficulty (δ_i), is mathematically expressed in the following equation (Bond & Fox, 2007):

$$p(x = k|\beta_n, \delta_i, \tau_k) = \frac{e^{(\beta_n - \delta_i - \tau_k)}}{1 + e^{(\beta_n - \delta_i - \tau_k)}} \quad (1)$$

In practice, the Rasch model gives two main measures: 1) item difficulty (δ_i); and 2) person ability(β_n). Both parameters are measured in logit units, where zero is generally set as the mean. For item measures, more positive (higher) values indicate higher item difficulty. For person measures, more positive (higher) values indicate higher person ability. Conversely, negative (lower) values indicate less difficulty for items and less ability for persons (Bond & Fox, 2007).

A primary assumption of the Rasch model is that responses should measure a single construct (unidimensionality), that is, the difficulty of healthy eating. This requires that the items evaluated as well as the participant responses fit a single underlying dimension. Unidimensionality can be tested by conducting principal component analysis of the residuals (Bond & Fox, 2007; Fox & Jones, 1998). As a rule of thumb, Linacre (2006) recommends that the variance explained by the Rasch dimension in the data should be greater than 60 percent, while the proportion of the remaining unexplained variance that is explained by the first contrast (second dimension) should be less than five percent.

Using factor analysis, the internal reliability of a scale can typically be assessed by its Cronbach's alpha score. The Rasch model has analogues reliability estimates for items evaluated and participant measures; namely, the item reliability index and the person reliability index. These indices are similar to the Cronbach's alpha, ranging from zero to one (Bond & Fox, 2007; Fox & Jones, 1998) with values above 0.80 generally considered to indicate good reliability.

The validity of the Rasch model construct can be assessed using various sources of information. Concurrent validity implies invariance of Rasch results across tests, but requires data from a validation sample (e.g., Fox & Jones, 1998; McCormack, Mâsse, Bulsara, Pikora, & Giles-Corti, 2006). Alternatively, a differential item functioning (DIF) test can be applied to different sub-samples. The underlying Rasch model assumption is that measures from different subsamples should not be significantly different (Bond & Fox, 2007; Higgins, 2007). Evidence of construct validity can be obtained from the item ordering; in particular, if the ordering from easiest to most difficult is consistent with theoretical and experience expectations (Fox & Jones, 1998). Further, the fit statistics of the Rasch model provides evidence of construct validity. The infit and outfit mean-square statistics have expected values of one; values greater/less than one indicate more/less variation between the observed and the predicted response patterns (Bond & Fox, 2007). Infit statistics are more frequently used; for rating scales the recommended range is 0.60–1.40, although a range of 0.50–1.50 is generally acceptable (Wright & Linacre, 1994). In addition to item infit statistics, similar person measures are estimated. Fit indices indicate whether items fit within the underlying construct that we intend to measure, and whether participants have responded in the expected way (Bond & Fox, 2007; Fox & Jones, 1998).

The Rasch model has been used in a number of behavioral studies. For example: Fischer, Frewer, and Nauta (2006) modeled household food handling practices directed at enhanced food safety. Heesch, Masse, and Dunn (2006) evaluated the impact of enjoyment, perceived benefits and perceived barriers on physical activity. Kahler, Strong, Read, Palfai, and Wood (2004) employed