Journal of Health Economics 50 (2016) 9–26

Contents lists available at ScienceDirect

Journal of Health Economics

journal homepage: www.elsevier.com/locate/econbase

# Non-monotonic health behaviours – implications for individual health-related behaviour in a demand-for-health framework

Kristian Bolin [a,b,*], Björn Lindgren [b,c,d]

[a] Department of Economics, University of Gothenburg, Gothenburg, Sweden
[b] Centre for Health Economics, University of Gothenburg, Gothenburg, Sweden
[c] Department of Health Sciences, Lund University, Lund, Sweden
[d] National Bureau of Economic Research (NBER), Cambridge, MA, USA

ARTICLE INFO

*Article history:*
Received 25 March 2014
Received in revised form 2 August 2016
Accepted 16 August 2016
Available online 26 August 2016

*JEL classification:*
I12

*Keywords:*
Human capital
Grossman model
Non-monotonic health investments
Health
Steady-state and stable equilibria

ABSTRACT

A number of behaviours influence health in a non-monotonic way. Physical activity and alcohol consumption, for instance, may be beneficial to one's health in moderate but detrimental in large quantities. We develop a demand-for-health framework that incorporates the feature of a physiologically optimal level. An individual may still choose a physiologically non-optimal level, because of the trade-off in his or her preferences for health versus other utility-affecting commodities. However, any deviation above or below the physiologically optimal level will be punished with respect to health. Distinguishing between two individual types we study (a) the qualitative properties of optimal time-paths of health capital and health-related behaviour, (b) the perturbations of the optimal time-paths that result from changes in exogenous parameters, and (c) steady state properties. Predictions of the model and the implications for empirical analysis are discussed at length. Some comments on potential future extensions conclude the paper.



## 1. Introduction

Most human behaviours are related to health. Individual health affects consumption patterns, but consumption patterns also affect individual health. While the intention of health-care utilisation is either to improve current health, whenever it has fallen below a certain illness-defining threshold value, or to prevent future illness, rather than to consume it for the sake of its direct utility (Arrow, 1963, p. 948), the intention of many other behaviours may be twofold: both to gain direct consumption utility and to improve health (or to decrease the risk of illness). The latter category includes, for instance, physical exercise, certain consumption and composition of food, alcohol consumption and, as a matter of fact, any recreational activity (art, literature, music, etc). Obviously, health effects may be more or less unintentional, and certain consumption patterns may also be detrimental to your health. Smoking is an unambiguous example of the latter.

Smoking is always bad for your health – and increasingly so with increased consumption (Colditz, 2000; Doll and Peto, 1976; Doll et al., 1994; Vineis et al., 2004).[1] In contrast, there appears to be a physiologically determined, individually optimal level of activity (greater than zero) as regards, for instance, physical exercise, food intake, alcohol consumption, and sleep, implying that activity levels below or above that level would result in a level of health which is lower than the maximum achievable level; see Fig. 1 for an illustrative example of a typically U-shaped relation.

A consistently positive association between physical-activity level and health-related quality of life has been found (Bize et al., 2007). Certainly, too small amounts of physical exercise means that the human body atrophies and that the risks of several diseases, including coronary heart disease, hypertension, stroke, diabetes, depression, osteoporosis, and cancers of the breast and colon, increase (Garrett et al., 2004). However, too much or too intensive physical exercise means that the human body will wear down and/or that the risk of injury increases (Howatson and van Someren, 2008; Ji, 2001; Locke, 1999; Morton et al., 2009; Randolph, 2008; Tisi and Shearman, 1998). A U-shaped association between all-cause mortality and dose of jogging has been found (Lee et al., 2015;

* Corresponding author at: Department of Economics, University of Gothenburg, Gothenburg, Sweden.
*E-mail address:* kristian.bolin@economics.gu.se (K. Bolin).

[1] There is, however, recent evidence showing that nicotine at low to moderate levels can have health and therapeutic benefits; specifically, the ability to act as a neuroprotectant has been demonstrated (Hurley et al., 2012).

http://dx.doi.org/10.1016/j.jhealeco.2016.08.003
0167-6296/

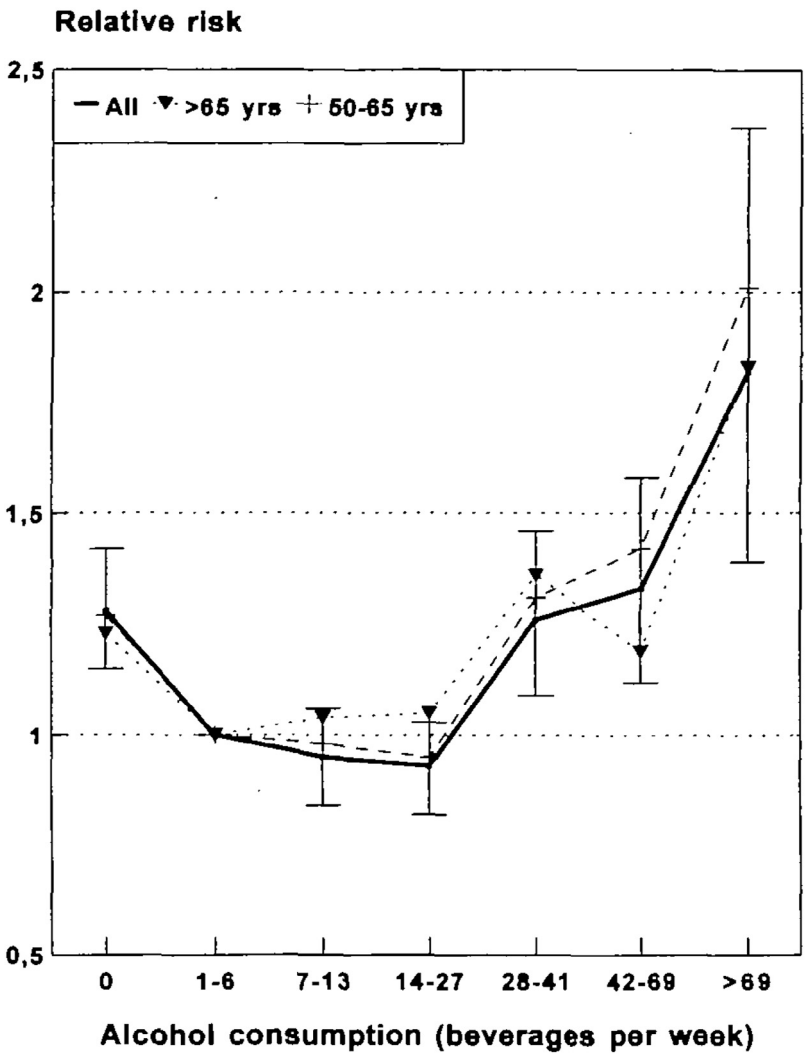


**Fig. 1.** Relative risk of mortality in relation to alcohol intake for middle-aged (-) and elderly (.....) people. Risk was set at 1.00 at lowest mortality at 1–6 beverages per week. Vertical lines are 95% confidence intervals for point depicting estimates for all subjects. (Reproduced from Grönbaeck et al., 1998 with permission from the Oxford University Press).

Schnohr et al., 2015). A varied and balanced diet is emphasised in guidelines on healthy eating; see, for instance Swedish National Food Agency (2015). Too little food or too one-sided diet leads to health problems (Steinhausen, 2002). Too much also creates health problems (Steinhausen and Weber, 2009), in particular in combination with too little physical exercise.

Overweight ($25 \leq BMI < 30$)[2] and obesity ($BMI \geq 30$) increase the risks of asthma, coronary heart disease, hypertension, diabetes, osteoarthritis, and cancer, including cancers of the breast and colon (Colditz, 1999; Must et al., 1999; Dal Grande et al., 2009). Also underweight ($BMI < 18.5$) has been shown to be associated with health problems; for instance, coronary heart disease, diabetes, and gallbladder disease (Must et al., 1999). Light to moderate drinkers are at lower risk of coronary heart disease, stroke, diabetes, and gallstone disease than non-drinkers, while an increasing intake increases the risks of dementia, liver cirrhosis, pancreatitis, osteoporosis, and most cancers, including cancer of the oesophagus, breast, pancreas, colon, and rectum (Grönbaeck, 2009). Finally, both short and long sleep durations appear to be related to increased likelihood of obesity, diabetes, hypertension, and cardiovascular disease (Buxton and Marcelli, 2010; Sabanayagam and Shankar, 2010).

It should be emphasised, though, that which level of physical exercise, food intake, alcohol consumption, and sleep is physiologically optimal differs among individuals, and if you have good genes and/or are lucky, you may suffer less from "unhealthy" behaviour than less advantaged people.

In general terms, these associations have been known for decades. Yet, there are no clear temporal trends worldwide towards healthier life-styles (Knuth and Hallai, 2009), and the population variance of these behaviours is large; for instance, many people do not perform any, or very little, physical exercise, others perform very large amounts. Some of this variance may be readily understood within the demand-for-health model (Grossman, 1972a, 1972b) both in its original version – see Muurinen and Le Grand (1985) and/or with minor extensions – see Galama and van Kippersluis (2013). The observed variance, however, seems to be greater than what would be expected, solely taken the variability in physiologically determined, individually optimal level of activity into account (Cutler and Gleaser, 2005).

In this paper, we develop a version of Grossman's demand-for-health model, assuming that there is a (strictly positive) physiologically optimal level of health behaviour and that the individual will be punished with lower health if exerting too much or too little of that behaviour. The emphasis is on extending theory

[2] BMI (body mass index) is calculated as weight in kilograms divided by the square of the height in meters ($kg/m^2$).