Social Indicators Research (2006) 79: 143–158
DOI 10.1007/s11205-005-4097-7

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BODY MASS INDEX, PERCEIVED HEALTH, AND HAPPINESS: THEIR DETERMINANTS AND STRUCTURAL RELATIONSHIPS

(Accepted 16 October 2005)

ABSTRACT. The structural relationships between body mass index, perceived health and happiness have been studied in a survey of 700 native Dutch citizens. We found an indirect effect of body mass index on happiness, via perceived health. Age had an inverted U-shaped relationship with body mass index, and both education and smoking had a negative effect on body mass index. Being married, doing paid work, owning a house, and doing sports had positive effects on perceived health, suggesting that living a regular life may lead to a better perceived health. Being married positively affected happiness. The other socio-demographic variables either had no effects on happiness or indirect effects via body mass index and perceived health.

KEY WORDS: body mass index, happiness, health, structural equations

INTRODUCTION

Overweight is a growing problem worldwide. In the US, current estimates indicate that mortality due to caloric intake and lack of exercise is second only to tobacco consumption in the number of deaths that could be prevented by a change in behaviour (McGrinnis and Foege, 1993; Philipson, 2001). In 2000, the World Health Organization has declared overweight to be the number one global epidemic. The Netherlands is one of the countries with the highest prevalence of overweight together with the US, UK and Germany (WHO, 2000).

Overweight has a negative effect on health because of the strong relationship between the prevalence of overweight and cardiovascular disease, coronary heart disease, cancer, diabetes (McGrinnis and

Foege, 1993; WHO, 2000; Philipson, 2001) and mortality (Fontaine et al., 2003; Peeters et al., 2003). However, the effect of overweight on overall health cannot be assessed from these results because it is not clear how the different physical aspects and symptoms should be combined in an overall measure of health (Gerdtham et al., 1999). Alternatively, a few studies have used subjective health measures to study its relationship with overweight and well-being. A UK study shows that overweight people have significantly lower scores for physical well-being than people with normal weight. Overweight and obesity are associated with decreasing levels of both physical and emotional well-being. However, this deterioration in health status is more evident in physical than emotional well-being, indicating that the burden of overweight is primary perceived as physical in nature (Doll et al., 2000).

The structural relationships between overweight, health and happiness still are little understood. Here, we aim at clarifying these relationships in addition to studying the socio-economic determinants of these variables. We use a Dutch survey of 700 people to estimate the relationships.

Next, we provide theoretical background of the variables studied. Consecutively, we describe the survey, the results of our study and a discussion of the results.

LITERATURE

This section deals with the concepts of body mass index, overweight, perceived health and happiness and their determinants. We also deal with the relationships between the concepts.

Body Mass Index

In the 1980s, almost 30% of the Dutch population was overweight (CBS, 2002c). Overweight usually is assessed by the body mass index (BMI), also known as Quetelet-index, which is defined as the weight in kilograms divided by the square of height in metres (kg/m^2) (Mathus-Vliegen, 1998a; WHO, 2000). People with a BMI less than 18.50 are considered underweight. A BMI between 18.50 and 24.99 is a recommended range, and is considered as normal weight. People

with a BMI equal to or exceeding 25.00 are considered overweight. The BMI classification is widely used and also recommended in Finland and other Scandinavian countries (Sarlio-Lähteenkorva and Lahelma, 2001). A number of factors influence BMI, including education, income, gender, age, and physical activity.

About 54% of the Dutch with only elementary school education is overweight, 36–48% of people with secondary school education (depending on type of education), and 31% of those holding a bachelor's or master's degree (CBS, 2001a, 2002a,b). Van Lenthe et al. (2000) also found a negative relationship between level of education and BMI.

Jeffery and French (1996) show that low-income women in the US are less attentive to their weight and more tolerant to weight gain than high-income women. Also low-income women perceived relatively little social support from friends for a healthy diet and exercising, and they engaged in relatively unhealthy weight control practices. On the other hand, in several US studies overweight affected pay and employment status, resulting in lower income, pointing to a reverse causal relationship (Register and Williams, 1990; Averett and Korenman, 1996; Pagán and Dávila, 1997). Van Lenthe et al. (2000) find a positive association of BMI with family income in males and a negative association with occupational level in females (Van Lenthe et al., 2000).

Van Lenthe et al. (2000) show that BMI among the Dutch is positively associated with age. Visscher et al. (2002) also find a positive relationship between BMI and age in the Netherlands (see also Jacobs and Gottenborg, 1981; Mathus-Vliegen, 1998).

BMI is associated with both energy intake and physical activity. A small positive energy balance over longer periods of time leads to large body weight increase. This means that with respect to energy use, overweight could easily be caused by a relatively small but prolonged surplus in energy intake (Mathus-Vliegen, 1998; Cutler et al., 2003; Health Council of the Netherlands, 2003; Lindström et al., 2003). Although between the periods 1987/1988 and 1997/1998, the mean energy intake in the diets of the Dutch population has decreased, there are strong indications that the amount of physical activity also has largely decreased during the last two decades. The decrease in physical activity must have been larger than the decrease in energy intake, given the high prevalence of overweight in the

Netherlands (Health Council of the Netherlands, 2003). Current public health guidelines advocate 30 minutes of moderately intensive exercise, at least five, if not all days of the week (Health Council of the Netherlands, 2003). About half the Dutch population does not meet this guideline (Ooijendijk et al., 2002).

In the Netherlands males spend more time doing sports than females (Ooijendijk et al., 2002). Yet, females are more likely to spend more time on physical activity during housekeeping in the US (Ross and Bird, 1994). Time spent doing sports generally decreases with age among the Dutch. Mediate and highly educated people spend about the same amount of time exercising, whereas lower educated people spend the least time. Furthermore, employees spend more time doing sports than the unemployed, homemakers and people who are retired (Salmon et al., 2000; Breedveld, 2001). Watching TV may also contribute to BMI through the consumption of snack food while watching (Burke et al., 2001). The share of watching TV in the total leisure time of the Dutch has grown from 21% in 1975 to 28% in 2000 (Huysmans and De Haan, 2001).

Health

Reidpath et al. (2002) show a positive relationship between BMI and the use of medical services including medication use, visits to hospitals, doctors, and other health professionals. On the other hand, for women a negative relation between overweight and preventive health services was found (Reidpath et al., 2002).

Health research generally has focused on the least ambiguous outcomes, such as the use of medical services, mortality, and prevalence of disease (Schultz, 1994). However, the perception of one's own health is considered one of the better indicators of health (Wannamethee and Shaper, 1991). Self-reported health is correlated with physical limitations and is therefore useful in our health analysis. In general, men report better health than women (Ross and Bird, 1994; CBS, 1999, 2001b) although women generally live longer than men (Schultz, 1994).

Several other factors may be related to perceived health since they are related to objective health indicators. Age (Maddox et al., 1987) and smoking (McGrinnis and Foege, 1993; Philipson, 2001) both may be negatively related to perceived health because they are known to affect the use of health services and mortality, respectively.

A related concept is quality of life, capturing both physical and mental components during the course of one's life (Scientific Advisory Committee of the Medical Outcomes Trust, 2002). Cutler and Richardson (1998) assign values between 0 (death) and 1 (perfect health) indicating a person's quality of life in any year. Subsequently, the expected remaining quality-adjusted life years (QALY) of a person can be added up (see also Bleichrodt and Johannesson, 1997; Dolan, 2000; Smith, 2000).

Happiness

In general, happiness is considered to be the ultimate goal of life, or at least desirable (Veenhoven, 2004; Frey and Stutzer, 2002). Happiness can be defined as the degree to which people positively evaluate their overall life situation (Veenhoven, 1997). Happiness may be considered as the affective aspect of the general concept of subjective well-being, whereas life satisfaction captures the cognitive aspect (Diener, 1984; Veenhoven, 1984). The most commonly used concept of subjective well-being in economic surveys is happiness (Easterlin, 2001; Frey and Stutzer, 2002).

Although the effects of BMI and perceived health on happiness are still largely unknown, research shows that overweight is significantly related with lower self-assessments of personal happiness in social groups where overweight is less common (Pinhey et al., 1997). This finding indicates that the socio-cultural environment may mediate the effects of BMI and perceived health on happiness. Some studies show a correlation between obesity and depression, further depending on the severity of the obesity (Larsson et al., 2002; Onyike et al., 2003; Groessl et al., 2004).

A number of other factors may influence people's happiness, including one's income, housing, leisure, friends, marriage (Easterlin, 2001a; Cohen, 2002; Van Praag and Ferrer-i-Carbonell, 2004), children, gender, age (Oswald, 1997; Plug, 1997; Argyle, 1999; Frey and Stutzer, 2004), level of education and work (Oswald, 1997; Argyle, 1999; Bowling and Windsor, 2001; Easterlin, 2001; Gerdtham and Johannesson, 2001; Frey and Stutzer, 2002), smoking (Delfino et al., 2001; Koivumaa-Honkanen et al., 2003; Rabois and Haaga, 2003) and religion (Myers and Diener, 1995; Levin and Chatters, 1998; Koenig et al., 2001; Cohen, 2002). In short, we could say that family

relationships and economic circumstances are the most important in influencing people's happiness, followed by one's own health, other people's health, work and social life (Bowling and Windsor, 2001).

DATA

The data was collected in the Netherlands in 2001 by a Dutch market research organisation. After checking the questionnaire in a pilot survey, data was collected by telephone in a random dialling procedure. Data concerning different ethnic groups will not be reported here and the analysis will be limited to the native Dutch. The average response rate in all ethnic groups was 23.4%, although the response among the native Dutch is likely to have been much higher.

It was explained to the respondents that the survey was held to obtain more insight in the life situation of the Dutch population, in particular their health. Part of the questionnaire dealt with the weight and height of the respondents, their perceived health, and happiness. Also, several questions concerning socio-economic and demographic variables were asked.

In the telephone interview, self-reported weight and height was the most simple and adequate way to gain insight in the prevalence of overweight. From this information, the Body Mass Index (BMI) was computed. This procedure is quite common and was used, for example, in Sarlio-Lähteenkorva and Lahelma (1999), Pinhey et al. (1997) and Lindström et al. (2003).

Respondents were asked to rate their own health on a five-point scale. The categorical health rating (self-reported health) was used in Cutler and Richardson (1998) and included five categories: ''excellent'', ''very good'', ''good'', ''fair'', and ''poor''.

To measure happiness, respondents were asked to indicate their overall happiness on a 10-point scale according to Cantril (1965). The 10-point scale was presented as a 'ladder of life' where the bottom indicated the worst possible life situation and the 10th step denoted the best possible life. The Cantril happiness scale has been used both in economic research (Van Praag and Frijters, 1999; Easterlin, 2001; Van Praag et al., 2003) and in other social sciences (see, for example, Diener et al., 1995).

RESULTS

The sample deviated to some extent from Dutch national statistics. Of the 704 respondents, 63% were female, 68% were married or cohabiting, and 42% had children at home. The average age was 47 years.

Regarding their body weight, 2% of the sample was underweight, 56% had normal weight, and 42% were overweight. These figures correspond closely with national BMI statistics (CBS, 2002a,b,c). Health was generally reported as very good (57%) or excellent (15%); 3% reported poor health, 5% reported fair health, and 20% reported good health. Happiness was rated 6 or lower on the 10-point scale by 11% or the respondents, 7 or 8 by 77%, and 9 or 10 by 12%.

We used structural equation modelling to estimate both the effects of socio-demographic (independent) variables (X) on the dependent variables BMI (Y_1), perceived health (Y_2) and happiness (Y_3), and the structural relationships between the latter three factors. The relations between the observed dependent and independent variables could be represented as follows:

$$Y_1 = \gamma_1 X + \varepsilon_1 \tag{1}$$

$$Y_2 = \gamma_2 X + \beta_{21} Y_1 + \varepsilon_2 \tag{2}$$

$$Y_3 = \gamma_3 X + \beta_{31} Y_1 + \beta_{32} Y_2 + \varepsilon_3 \tag{3}$$

where the γ's and β's are regression coefficients and the ϵ's are error terms. We assumed direct effects of BMI (Y_1) on perceived health (Y_2) and happiness (Y_3), and of perceived health (Y_2) on happiness (Y_3) but not in the reverse direction. We have used Maximum Likelihood to estimate the parameters. The estimation results are shown in Table I.[1]

Partly due to the nearly identified model, the fit indices for the model were very good: $\chi^2 = 0.112$ (df $= 4$, $p = 0.998$), and goodness of fit (GFI) equalled 0.999. Although the R^2s of the structural equations were relatively low, a significant amount of variance in the dependent variables was explained.

TABLE I

Maximum Likelihood estimates of the structural equations (absolute *t*-values between brackets)

	BMI	Perceived health	Happiness
Dependent variables			
BMI	Fixed	−0.030 (4.010)[a]	−0.015 (1.715)[c]
Perceived health	Fixed	Fixed	0.309 (7.096)[a]
Happiness	Fixed	Fixed	Fixed
Independent variables			
Female	−0.661 (1.920)[c]	−0.051 (0.744)	−0.023 (0.288)
Age	0.174 (3.077)[a]	−0.010 (0.880)	0.006 (0.447)
Age squared	−0.001 (2.433)[b]	0.001 (1.089)	−0.001 (0.584)
Married/cohabiting	0.394 (1.019)	0.258 (3.189)[a]	0.183 (1.965)[b]
Children aged 0–3	Reference group	Reference group	Reference group
Children aged 4–11	−0.091 (0.338)	0.027 (0.504)	−0.033 (0.548)
Children aged 12–15	−0.148 (0.585)	0.015 (0.304)	0.040 (0.527)
Children aged 16–25	−0.282 (1.672)[c]	Fixed	−0.049 (1.282)
Children aged > 25	−0.084 (0.102)	−0.103 (0.634)	0.139 (0.749)
Low level of education	Reference group	Reference group	Reference group
Medium level of education	−1.358 (3.263)[a]	−0.086 (1.029)	−0.080 (0.843)
High level of education	−2.178 (4.692)[a]	−0.010 (0.099)	−0.136 (1.234)
Household income (net p/m)	Fixed	0.001 (0.645)	0.001 (1.857)[c]
Unemployed	3.507 (2.328)[b]	0.633 (2.104)[b]	0.529 (1.536)
Working hours 1–20 p/w	−0.353 (0.675)	0.120 (1.159)	0.084 (0.712)
Working hours 21–40 p/w	−0.592 (1.426)	0.251 (2.992)[a]	−0.036 (0.379)
Working hours > 40 p/w	Reference group	Reference group	Reference group
Living in urban area	−0.353 (0.662)	−0.067 (0.637)	Fixed
Religious	0.099 (0.252)	−0.012 (0.151)	0.088 (0.992)
Homeowner	−0.281 (0.744)	0.160 (2.117)[b]	0.094 (1.094)
Sports seldom/never	Reference group	Reference group	Reference group
Sports 1–2 times p/w	−0.692 (1.605)	0.109 (1.270)	0.064 (0.709)
Sports 2–3 times p/w	−0.242 (0.585)	0.261 (3.185)[a]	Fixed
Sports > 3 times p/w	0.760 (1.354)	0.299 (2.679)[a]	−0.132 (1.652)[c]
Smoking	−0.960 (2.737)[a]	−0.232 (3.316)[a]	−0.132 (1.652)[c]
Error covariance matrix			
BMI	16.944 (18.426)[a]	Fixed	Fixed
Perceived health	Fixed	0.668 (18.426)[a]	Fixed
Happiness	Fixed	Fixed	0.872 (18.426)[a]
R^2	0.136	0.109	0.071

Note: All fixed coefficients were set to zero.
[a]$p < 0.01$; [b]$p < 0.05$; [c]$p < 0.10$.

We found a strong negative effect of BMI on perceived health, indicating that high BMI scores led to relatively low health ratings, as expected. Perceived health had a very strong positive effect on

happiness, which is consistent with findings from the literature (see coefficients concerning the dependent variables in Table I). BMI had a small negative effect on happiness, significant only at the 10% level.[2] These results indicate that the effect of BMI on happiness is mainly indirect, via perceived health.

The effect of gender on BMI was significant only at the 10% level, indicating that women generally had somewhat lower BMI scores than men, in agreement with the literature (see coefficients concerning independent variables in Table I). Both age and age-squared were significant in the BMI equation. The negative sign of age-squared indicated that age had an inverted U-shaped relationship with BMI, reaching its peak at the age of 63. This result is partly consistent with the literature. Since we have cross-section data, we are unable to tell whether this relationship concerns an age effect or a generation effect. The effect of marriage or cohabiting on BMI was not significant, contrary to earlier findings.

We have tested the effect of education by including three categories of schooling completed. Since we used the lowest level of schooling as the reference category, this category was omitted from Table I. Table I indicates that having secondary education, pre-university education or intermediate vocational education led to lower BMI-scores than having primary school or vocational education. University education led to even lower BMI-scores. These results were in agreement with earlier findings and they indicate that either general knowledge or a life-style adopted by higher education groups led to relatively low BMI indices. Smoking had a strong negative effect on BMI. We have tested the effect of doing sports on BMI by including four categories of exercise frequencies (''no exercise,'' ''one time per week,'' ''2–3 times per week,'' ''more than 3 times per week''). The ''no exercise'' category served as reference category and was omitted in Table I. Neither of the exercise categories differed significantly from the reference category, indicating no effect of doing sports on BMI, contrary to findings in the literature.

The effects of age and education on perceived health were not statistically significant. This result suggested that the age and education effects on health were indirect, via BMI. The indirect effects of age and education on perceived health (not reported here) were significant indeed, supporting this view. Being married or cohabiting had a strong positive effect on perceived health. Doing paid work for

21–40 hours a week led to a better perceived health than either shorter or longer working hours. Also, owning a house led to significantly better perceived health. These results suggest that living a regular life with different obligations and responsibilities leads to a better perceived health. Furthermore, doing sports two or more times per week positively affected perceived health, as expected.

Happiness was positively affected by being married or cohabiting. The indirect effect, via perceived health was even higher (not reported here). Household income had a small positive effect on happiness, significant at the 10% level only. Smoking had a small negative effect on happiness, only significant the 10% level. The other socio-demographic variables either had no effects on happiness or indirect effects via BMI and perceived health.

Our results show that BMI, perceived health and happiness are structurally related and are determined both directly and indirectly by socio-demographic variables.

DISCUSSION

BMI appeared as an important determinant of perceived health. Hence, reducing BMI in society should increase health perceptions in the population. In turn, perceived health should increase happiness in society. We did not find evidence of reverse causal effects.

Both age and education appeared as major determinants of BMI. The age effect suggests directing policy measures to reduce BMI at people aged less than 60 years. Probably, policy issues directed at young people will be particularly relevant because of learning effects which will benefit young people in their later lives. The education effect on BMI may be due to higher capability to obtain information about the consequences of behaviour regarding food intake and physical activity, or to more healthy lifestyles related with higher education.

Doing sports did not affect BMI directly, which may be due to a lagged effect of physical activity on BMI. It may be the case for many people that only after becoming overweight, they decide for doing sports. However, doing sports may not immediately reduce overweight. In this case, our cross-section data did not pick up the long-run effect of weight reduction due to physical exercise. Longitudinal data should be used instead.

Several factors, including being married or cohabiting, moderate working hours, and owning a house, had a positive influence on perceived health. In our opinion, this effect may be due to leading a regular life. Living together may smooth one's social life and regulate meal times. Moderate working hours may be optimal because it avoids negative effects of being unemployed on the one hand, and wear-out due to long working hours on the other hand. Owning a house requires maintenance and other responsibilities demanding constant attention. We believe that a regular life has a positive effect on perceived health because it avoids (negative) peak experiences. A deregulated life is associated with large variation in experiences, both positive and negative. Since negative experiences generally count heavier than positive experiences, the resulting evaluation will be relatively negative (Kahneman, 1994; Kahneman et al., 1997).

Although longitudinal effects could not be observed using our cross-section data, we have found some evidence of one-directional causal relationships between the dependent variables. Furthermore, in order to simplify the model, we have considered a number of variables as independent. In some cases, the choice of independent variables may be questioned. For example, doing sports might have been considered as dependent, since overweight might reduce the possibility of doing sports. Alternatively, happiness may be considered as a personality characteristic, i.e., as an independent variable also. We have specified our model according to the most common findings in the literature.

One should be careful in generalizing the results of our study to other cultures or different ethnic groups. Due to different preferences for body mass, the effects of overweight on happiness may be different across cultures (Pinhey et al., 1997).

We have used self-reported measures of weight and height, which might have led overweight people to underestimate their weight, and underweight people to overestimate. Since the BMI distribution in the sample is highly similar to the distribution in the population, we believe our results can be considered as reliable. To the extent that underestimation has occurred this may have reduced the power of our statistical tests, so to the disadvantage of our estimation results.

We have studied a sample including a wide range of BMIs. However, since only 2% of the sample was underweight, our results are mainly limited to the normal and overweight groups and may not

be valid at the lower BMI range. On the other hand, the small underweight group indicates that the main societal problem is the overweight group, for which we believe our results are relevant.

NOTES

[1] Although Equations (1)–(3) may be estimated separately, the errors might be correlated. In the first instance, we allowed correlation between the error terms of the equations, fixing a few γ-coefficients at zero for identification purposes. It turned out that the error co-variances were insignificant and close to zero. In the second instance, we assumed the error co-variance matrix to be diagonal. Furthermore, we specified an over-identified model in order to estimate modification indices for the β coefficients that were set to zero. In this way, we tested our assumptions regarding the causal relationships among the dependent variables Y in Equations (1)–(3). All modification indices indicated that the fixed coefficients would not be significantly different from zero if they were set free, thus supporting our assumptions regarding the one-directional causal relationships among the dependent variables.

[2] In a different analysis, not reported here, we included BMI-squared in the happiness equation. Since the coefficient of BMI-squared was not statistically significant, we did not find evidence of a non-linear relationship between happiness and BMI.

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