TIME DISCOUNTING FACTORS ASSOCIATED WITH BODY MASS INDEX: A THEORETICAL REVIEW

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ABSTRACT

Obesity around the world is a major public health concern. Media reports and statistics indicate that most nations around the world are not spared from this concern and are disproportionately affected. The purpose of this paper is to re-examine prior researches conducted in this domain and to further explore the associated factors that predict variation in body mass index (BMI). This review is an attempt to close the gap in literature using time discounting and further extends health economic theoretical model to provide a better understanding of the development of obesity. Specifically, this paper reviews the effect of physical activity, smoking consumption and dietary habits and its effect on BMI. Prior researches suggest that dietary habits factor could play a mediating role between physical activity, and smoking consumptions on variation in BMI. Importantly, a conceptual model is proposed and is adapted from the health economic theory (HET), following which, a set of propositions are developed and directions for future research are recommended.

Key words: obesity, health economic model, time discounting, physical activity, smoking habits, dietary habit

1. INTRODUCTION

The prevalence of overweight and obesity is increasing worldwide at an alarming rate. Both developed and developing countries are affected. In low-income countries, obesity is more common in middle-aged women, people of higher socioeconomic status and those living in urban communities. In more affluent countries, obesity is common not only in the middle-aged, but is also becoming increasingly prevalent among younger adults and children. Furthermore, it tends to be associated with lower socioeconomic status, especially in women, and the urban–rural differences are diminished or even reversed (WHO 2009). According to Nammi et al. (2004), obesity is described as the state of imbalance between the expenditure of calories versus caloric intake, which ultimately leads to excess fat accumulation and can be measured by Body Mass Index (BMI). Recent statistics showed that approximately 300 million people in the world are obese (Wilborn 2005). For instance, the prevalence of obesity in the United States (U.S) alone is a major public health concern. According to the 2003-04 National Health and Nutrition Examination Survey, 32 percent of U.S adults age 20 years and older are obese, with men at 31 percent and women at 33 percent (Ogden et al. 2006). In 2003-04 approximately 30 percent of U.S non-Hispanic white adults were obese as were 45 percent of non-Hispanic blacks and 37 percent of Mexican-Americans (Ogden et al. 2006). The number of overweight and obese people, particularly children, has also reached epidemic levels in developed and newly industrialized countries. It has also started to rise in developing countries in which deficiency diseases and malnutrition still represent a major public health problem.

The health consequences of obesity are many and varied, ranging from an increased risk of premature death to several non-fatal but debilitating complaints that adversely impact quality of life. Obesity is a major risk factor for non communicable diseases (NCDs) such as non-insulin-dependent diabetes mellitus, cardiovascular diseases (heart disease, stroke and hypertension) and cancer, and in many industrialized countries it is associated with various psychosocial consequences. Abdominal obesity is a particular area of concern as it is associated with elevated risks to health in comparison to a more peripheral fat distribution. Obesity has very high costs for societies, as the resulting disabilities and diseases create huge burdens for families and health systems. The experience of developed countries clearly demonstrated that the cost of morbidity and mortality associated with increasing obesity would be overwhelming for developing countries.

2. OBJECTIVES OF THE STUDY

The major purpose of this paper is to re-examine the extent to which a health economic theoretical approach can predict variation in BMI. Particularly, time discounting factors, measured by smoking consumption, physical activity, and dietary habits factors are closely examined. In addition, this study seeks to examine the relative significance of time discounting factors in explaining changes in BMI. In so doing, this study seeks to close the gap in literature research by re-examining the factors contributing to obesity and what is lacking in terms of behavioral science perspective. Several studies have examined the influence of physical activity, smoking consumption, and dietary habits on weight gain. However, to date no study has examined the possible mediating effect of dietary habits and its effect on obesity. Thus, the overall goal of this paper is to develop and propose a conceptual framework that better captures obesity development. Specifically, this paper review the literature and re-examine the role of physical activity, smoking consumption and dietary habit and its variation effects on BMI. In addition, the possible mediating effect of dietary habit between physical activity and BMI, and between smoking consumption and BMI are examined (see figure 1 for illustration).
Thus, this paper attempts to address the following research questions:
1. Does physical activity contribute to obesity?
2. Does smoking consumption contribute to obesity?
3. Does dietary habit contribute to obesity?
4. Does dietary habit mediate the relationship between physical activity and obesity?
5. Does a dietary habit mediate the relationship between smoking consumption and obesity?

3. LITERATURE REVIEW

Health economic theory (HET) is used for the present work to explain the relationship between time discounting, and the dependent health outcome of obesity measured by Body Mass Index (BMI). According to Huston and Finke (2003), time discounting is established from the theory of human capital. The theory of human capital recognizes that “health is a stock within one’s own human capital” (Huston & Finke 2003). Thus, health is an investment that one makes over time. This health investment is a function of time discounting. HET suggests that individuals who discount the future and engage in risk taking behavior are more likely to have poor health outcomes due to a lack of investment in their health (Huston and Finke 2003). The time discounting aspect of HET suggests that lifestyle choices are centered on changes in individual preferences, which are in turn a function of the distance or time span in which a specific outcome will occur - with the saliency of the cost and benefits potentially affecting how ultimate decisions are made (Areily & Zakay 2001). If the benefits of a choice are too far off, research shows that the future is discounted and the sooner, immediate gratification of a choice outcome is preferred, even if it is smaller or less beneficial (Chapman 2005). These changes in preferences can be systematic (Areily & Zakay 1990).

A ‘beneficial choice’ (physical activity), will have a higher value or utility prior to the decision being made. A ‘costly choice’ (sedentary behavior), will have more value or be more enticing immediately prior to the decision being made to engage in physical activity. After the decision is made, in retrospect, the choice to lead a sedentary lifestyle becomes questionable and is less of a ‘reward’ than engaging in physical activity. Thus, when the future is devalued more than the present or the rate of discounting of the future is high; the value of future outcomes is low due to the time delay (Chapman 2005). The choice factor in time discounting is an essential connection to economics as the concept is associated with behaviors that have tradeoffs between one activity over another. Empirical studies suggest that time discounting explains a host of behaviors including addictive and addictive-related behaviors such as gambling, drug use, alcohol consumption, needle sharing, dietary habits and smoking (Chapman 2005; Huston & Finke 2003; Khwaja et al. 2006). Researchers have developed proxy constructs which include indicators of time discounting for non-experimental research. With this method, the value that one places on health status by measuring future discounting through time-based indicators consist of demographic variables, measurements of impatience, self-restraint and perceived health risk to further understand the extent to which short-term gains are preferred over long-term rewards (Read et al.2004; Huston & Finke 2003; Chandran, et al. 2004; Van der pol, et al. 2000; Chapman, 2000). Such indicators of self-control and demographics were found to be better determinants of wellness outcomes as a function of time discounting. Thus, physical activity, dietary habits and smoking consumption are used to gauge time discounting. One’s investment in their stock of health would then involve increased physical activity and decreased intake of alcohol and tobacco. Therefore, those who do not discount the future and do invest in their health would be engaged in physical activity, and consume less tobacco which would relate to a lower BMI.

![Proposed Conceptual Framework](image)

**Fig. 1. Proposed Conceptual Framework**

3.1. Dietary habit and obesity

Harvey and Hill (2001) conducted a survey of 764 health professionals in two health districts in the north of England to examine health professionals’ views of overweight people, to compare these to their views of smokers, and to explore the role of level of severity on these perceptions. It was found that the most important perceived causes of extreme overweight was food addiction. Many other factors such as personality, external stressors, mood changes, genetic factors, lack of willpower, socio-economic status and repeated dieting, were perceived as somewhat important. Compton, et.al (2006) conducted a review using searches of the MEDLINE database, from 1996 through April 2006, in the U.S. The findings of their study suggested that the weight gain associated with psychotrophic medications was often associated with increased appetite (commonly a craving for sweet and fatty foods), as well as increased total caloric intake. Poor eating habits and sedentary lifestyle were risk factors for
obesity in the general population and contributed to elevated rates of overweight/obesity in individuals. In the Czech Republic, Kubisová et al. (2007) have examined a total of 201 homeless (174 males and 27 females) aged 19-70 years to describe the prevalence of some of the major cardiovascular risk factors, namely high total cholesterol and triacylglyceride levels, smoking and obesity in those members of Prague's homeless community. It was found that abdominal obesity was positively correlated with the intake of total fat and negatively correlated with protein intake. In Scotland, Akbartabartoori et al. (2007) studied 5,460 adults aged 16 to 74 years old. The mean cholesterol and non-high-density lipoprotein cholesterol (non-HDL-C) were significantly higher in overweight and obese subjects. After controlling for age, gender, social class, smoking, alcohol intake, and fruit and vegetable consumption, inactivity, overweight and obesity were associated significantly with higher OR for elevated cholesterol, C-reactive protein (CRP), systolic blood pressure, non-HDL-C and lower high-density lipoprotein cholesterol (HDL-C) than inactive with BMI <25 kg/m2. In England, 5,863 students took part in the HABITS (Health and Behavior in Teenagers) survey conducted by Fidler et al. (2007). The study was conducted to assess the effect of smoking uptake on body mass index (BMI), waist circumference and height during adolescence. It was found that dieting behavior were associated with BMI. Restrained eating was associated with BMI. To summarize, there appears to be reasonably good supportive evidence to suggest that dietary habits tend to have an effect on body mass index. This leads to the following proposition:

Proposition 1. Dietary habits is positively associated with obesity.

3.2. Physical activity and obesity

In a cross-sectional Scottish Health Survey 1998 data on 9047 adults aged 16-74 years, Akbartabartoori et al. (2004) evaluated the relationships between physical activity levels and body mass index (BMI), waist and hip circumferences (WC, HC) and waist-to-hip ratio (WHR). The prevalence of BMI ≥ 30 kg/m2 in each category of physical activity (A-D) was 27.5, 21.3, 16.2, 7.2, 10.2% in men and 33.3, 21.4, 15.5, 21.8, 12.7% in women, respectively. The mean BMI of participants in level E (26.0 in men and 25.2 kg/m2 in women) and in level C (26.4 in men and 25.6 kg/m2 in women) were significantly lower than the mean BMI in level A (27.1 in men and 26.8 kg/m2 in women). The same trends were seen for WC and WHR but not HC. The results supported the view that moderate activity for 30 minutes and 5 days a week may help prevent weight gain, but vigorous activity has more limited value. In Harvey and Hill (2001) study to examine health professionals’ views of overweight people, the most important perceived causes of extreme overweight was physical inactivity factor. For both levels of overweight moderate and extreme, physical inactivity was rated as the most important causative factor. Peeters et al. (2003) conducted a study with 3,457 Framingham Heart Study participants aged 30 to 49 years of age at baseline in Massachusetts, U.S., to analyze reductions in life expectancy and increases in premature death associated with overweight and obesity. The analysis of data from the Framingham Heart Study from 1948 to 1990 showed that, on average, adults who were obese (body mass index [BMI] 30 kg/m2) at age 40 years lived 6 to 7 years less than their normal-weight counterparts. Adjustment for physical activity and education had no effect on the risks associated with BMI in any of the four strata. In Rohrer et al. (2005) study, 747 samples were drawn from three clinics that primarily serve low-income populations in Texas, U.S., among adults aged 35 and above. The study focused on how frequency of alcohol use was related to the risk of obesity in a community medicine clinic population. The findings indicated a significant association between watching eight or more hours of television per day and obesity. Less television time was independently associated with reduced odds of obesity in this sample of community medicine patients. There was a strong association between watching eight or more hours of television per day and obesity. In Compton et al. (2006) review, the authors suggested that the high prevalence of obesity found especially in women with severe mental illnesses was likely due in large part to lifestyle factors such as sedentary lifestyle. Jasuja et al. (2008) conducted a study from a drug abuse prevention trial, (N= 414), with subjects participating from aged 11-34 years in the U.S. The study examined the simultaneous longitudinal relationships of cigarette use in adolescence to continuing cigarette use, psychological distress, physical activity, subjective rating of health in emerging adulthood and, finally, to body mass index (BMI) in early adulthood. Physical activity had significant negative relationships to BMI in early adulthood. Gender was a significant predictor of physical activity in the mid emerging adulthood wave, and BMI in the early adulthood period. These results suggested that females have lower physical activity levels, and lower BMI compared with males. To summarize, there appears to be reasonably good supportive evidence to suggest that physical activity and inactivity tend to have an effect on body mass index. This leads to the following proposition:

Proposition 2. Physical activity is positively associated with lower BMI.

3.3. Smoking habit and obesity

Many studies have found an association between smoking habit and obesity. Barrett & Khaw (1989) conducted a study with older adults, aged between 50 and 79 in the U.S. The objective of the study was to determine whether cigarette smoking was associated with central obesity between men and women. Their results indicated that cigarette smokers had higher waist-hip ratios than non-smokers. A dose response relation of increasing waist-hip ratio with increasing number of cigarettes smoked. Although smokers were leaner than non-smokers, the increased waist-hip ratio in smokers was independent of body mass index and was consistent within body mass index tertiles. The associations, seen in both sexes, were stronger in women. Cigarette smokers had more central obesity than non-smokers. The results suggested that body fat body distribution could be modified by behavioral factors such as smoking. Cigarette smokers usually weigh less than nonsmokers, and often gain weight when they stop smoking. Consequently, smoking was postulated as a confounder of the relation between...
overweight and mortality. Using data collected from, a population-based study of diabetes and cardiovascular disease, Burke (2000) have examined the association between smoking cessation and weight gain in 1,930 Mexican Americans and 1,126 non-Hispanic whites (NHW) in the U.S. The findings indicated that a two-fold greater percentage of Mexican Americans quitters than Non Hispanic Whites quitters became overweight or obese. However, this difference did not quite reach statistical significance. Using linear regression to predict change in weight or body mass index from baseline to follow-up, smoking cessation was predictive of either weight gain or BMI gain. Those who ceased smoking weighed more at baseline, gained more weight between baseline and follow-up, and had a greater change in BMI. The continuous smokers had the lowest BMI at baseline. Bamia (2004) conducted a study with a total of 22,059 men and women, aged 25–84 years in Greece to investigate the effects of variable amounts of tobacco smoking on body mass index and waist-to-hip ratio among current smokers.

In comparison to nonsmokers, smokers of the average number of cigarettes have lower body mass index. Among smokers, however, increased amount of smoking tended to be positively associated with body mass index and the association was somewhat stronger among men. After adjusting for body mass index, waist-to-hip ratio was positively associated with amount of cigarettes smoked per day, among both men and women. When comparing nonsmokers with smokers of the average number of cigarettes, however, with respect to waist-to-hip ratio smokers had higher mean value among men, whereas among women there was a suggestion that the opposite could be true. When smokers of the average number of cigarettes were compared to nonsmokers, however, the former were found to have lower body mass index. The apparent contradiction was explained by postulating that smokers, on account of their personality and lifestyle characteristics, tended to be lighter rather than heavier in comparison to nonsmokers. Tobacco smoking was positively associated with body mass index and waist-to-hip ratio. The results of the study indicated that the lower average body mass index among smokers was due to personality and lifestyle characteristics of the smokers rather than to direct effects of smoking since, among smokers, there was a positive association of amount of smoking with body mass index. This interpretation was not incompatible with existing evidence from other studies and indeed the few investigations that have evaluated dose response of body mass index in relation to tobacco smoking with adequate control for possible confounding reported a positive association. The data indicated that the lower body mass index of smokers compared to nonsmokers reflected personality characteristics of those who choose to smoke and that the tendency to gain weight after smoking cessation may have behavioral rather than tobacco-related pharmacological roots. In a questionnaire survey of 3000 men, randomly drawn from the Danish Civil Registration System, Nielsen et.al (2006) have assessed the prevalence of overweight, obesity and physical inactivity in 20 to 29 year-old men and have analyzed whether socio-demography, physical dysfunction and low socioeconomic status were independent correlates of obesity. The findings of the study indicated that the ORs for obesity were lower in men moderately exposed to tobacco compared to unexposed men. Compared to moderately exposed men, the ORs for obesity were increased in heavily exposed men. Park (2009) have used data from the 2004-2005 Minnesota Survey on Adult Substance Use, a statewide telephone survey (N=16289) in U.S to examine gender's role as a moderator in the association of relative body weight to smoking and mental health. The findings however, indicated no significant relationship between current smoking and body weight. To summarize, there appears to be reasonably good supportive evidence to suggest that smoking consumption tend to have an effect on body mass index. This leads to the following proposition:

Proposition 3. Smoking consumption is positively associated with lower BMI.

3.4. Establishing the mediating effect of Dietary Habits

3.4.1. Physical Activity and Dietary Habit

A study Huston & Finke (2003) was conducted to explore factors that predicted the variation in a person's diet quality with a sample of 5,465 respondents, aged 20 and older in the U.S. It was hypothesized that those who had the highest levels of education, did not smoke, did exercise and use nutrition labels and were motivated to have nutrition knowledge were hypothesized to have the lowest future discount rates and the highest Healthy Diet Score. The results for the study indicated that respondents who exercised regularly had higher Healthy Eating Index (HEI) scores compared to non-exercisers. The low HEI profile included consumers with the highest discount rates, i.e., less than high school education, smokers, non-exerciser. The market characteristics for this profile included those living in the South region, in a rural area, with low level of income. The socio-cultural factor profile contained respondent who were Black, males less than 35 years old.

3.4.2. Smoking Habit and Dietary Habit

Delahanty et.al (2008) have used a representative sample of 2,066 women participating in the Maryland Women, Infants, and Children (WIC) Food for Life Program in the U.S to examine whether dietary attitudes and demographics differed based on smoking status among low-income women participating in a dietary intervention. Relative to non-smokers, current smokers reported significantly higher overall calories; higher percentages of calories from fat, sweets, and alcohol; and lower percentage of calories from protein. Never smokers who received the dietary intervention evidenced the greatest dietary changed over time. Women who were current smokers reported significantly higher overall calories in their diets than never or former smokers. Current smokers also reported a significantly higher percentage of calories from fat than former smokers reported. Current smokers received significantly higher percentages of calories from sweets and alcohol and a lower percentage of calories from protein than did women who were never or former smokers. Current smokers, despite reporting higher calories and deriving more calories from fat, sweets, and alcohol, had significantly lower mean BMI compared to both former and never smokers. Results revealed a significant positive linear trend for the levels of cigarettes
smoked and the percent of calories derived from sweets. Women who smoked fewer than 5 cigarettes a day reported the lowest percentage of calories, followed by women who smoked between 5 and 10 cigarettes and women who smoked between 11 and 20 cigarettes and women who smoked 21 or more cigarettes a day reported the highest percentage of calories from sweets. Women who smoked 21 or more cigarettes a day received a significantly lower percentage of calories from protein than did women who smoked lower levels of cigarettes a day. In the study however, the number of cigarettes smoked was not significantly associated with the percent of calories from fat, carbohydrates, or alcohol or BMI. A study conducted by McClernon et al. (2007) among 209 adult smokers consecutively enrolled in six studies over a 3-year period (2002-2004) in U.S has sought to systematically evaluate the prevalence and diversity of the taste altering effects of foods and beverages on cigarette palatability. The goal of the study was to survey these effects in smokers and attempt to identify factors that influenced sensitivity to worsening and enhancing of smoke taste. A total of 94 participants (44.9%) reported foods and beverages worsening the taste of cigarettes. The most common categories worsening the taste of cigarettes were fruits and vegetables, noncaffeinated beverages (e.g., water, juice), dairy beverages, and dairy food products. The most common categories enhancing the taste of cigarettes were caffeinated beverages, alcoholic beverages, and meat. Taste-worsening effects were associated with age, years smoked, education level, and type of cigarette. Taste-enhancing effects were associated with cigarettes smoked per day, education level, type of cigarette, and, marginally, years smoked. Younger age and smoking non menthol cigarettes were significantly associated with increased likelihood of reporting any foods or beverages worsening the taste of cigarettes. Smoking fewer cigarettes per day and smoking non menthol cigarettes were significantly associated with an increased likelihood of reporting any foods or beverages enhancing the taste of cigarettes. This could explain the negative association with a healthy dietary habits among smokers. White et al. (2007) used a consecutive series of 91 obese participants [body mass index (BMI) > 30] in the U.S to compare obese female former smokers with binge eating disorder (BED) to women with BED with no smoking history in the severity of binge eating and associated symptoms. Their findings indicated that never-smokers and former smokers did not differ in terms of BMI. Smoking groups did not differ in the frequency of days in the past month in which they attempted behavioral dietary restraint (i.e., restricting food intake), endorsement of dietary rules, or food avoidance. However, the former smokers endorsed more days in the past month in which they avoided eating for eight or more waking hours and desired to have an empty stomach. Compared to never-smokers, former smokers endorsed significantly higher levels of dietary restraint and rigid dieting strategies. The correlation between BMI and “restricting intake” and “wanted an empty stomach” differed significantly between the never and former smokers.

The review of prior research conducted in various demographic settings suggests the following propositions:

**Proposition 4:** Physical activity is positively associated with healthy dietary habit, which in turn leads to lower BMI.

**Proposition 5:** Smoking consumption is negatively related to healthy dietary habits, which in turns leads to lower BMI.

4. CONCLUSION AND DIRECTION FOR FUTURE RESEARCH

Health Economic Theory (HET) involves the concept of human capital investment and the importance of the individual in making optimal health decisions. The theory is underscored in behavioral economics, which joins the psychology behind decision-making with economic theory in identifying that individuals make choices based on utilities. The theory proposed that one has a certain amount of human capital, which is in turn influenced by environmental factors that makeup human capital in its entirety. The quality of this human capital stock differs between individuals and is to some degree controlled by the individual. Thus, health is viewed as being ‘endogenous’ and becomes a function of actions expended overtime in being maintained and improved (Huston and Finke 2003). The individual is the center of this theory. In addition, there are market and socio-cultural components that affect health outcomes in terms of resources and cultural meanings of a healthy lifestyle. The theory is also sociological, as central to the theory are lifestyle factors and environmental factors including structural location in society and socio-cultural determinants that affect health outcomes. This study seeks to re-examine at-risk group in terms of predictors of obesity. HET allows for a look at individual lifestyle predictors indicators. These predictors include 1) time discounting measures of dietary habits, smoking consumption and physical activity. The research objectives of this study was to explore the extent to which the independent variables, as a whole, are good predictors of BMI, and the extent to which the key independent construct, time discounting, is a significant differential predictor of BMI. HET informs the research objectives for this study because its centralized focus is that the individual makes lifestyle choices that impact health outcomes.

The investigation gathered could help us to understand better the development or factors affecting obesity, which is a rising concern globally, regardless of ethnicity, cultural background, or age. This study is expected to contribute to the extensive body of knowledge that exists and to address the current ongoing debate worldwide on the preventive measures which could be adopted to reduce obesity among young adults in particular. In addition, research shows that lower prevalence of abdominal obesity was found among infrequent alcohol users (Tolstrup et al. 2008). Tolstrup and colleagues (2008), sought to test the proposition that drinking frequency was associated with changes in waist circumference. The authors suggest that drinking pattern may be related to the development of adiposity. Drinking frequency was found to be inversely related to major weight gain. Future research could further investigate the relationship between dietary habits and alcohol consumption to expand the current proposed conceptual model presented in this study. Furthermore, prior research have also showed that longitudinal
predictors of one year weight gain among women included both increases in caloric intake and decreases in leisure-time physical activity (Chiriboga et al. 2008). For men, anxiety scores were the top predictors of weight gain over time (Chiriboga et al. 2008). On average, over the one year study period, the men gained 3 kg and women lost 2 kg (Chiriboga et al. 2008). Cross-sectional data at baseline illustrated that predictors of lower body weights were current cigarette smoking, increased leisure-time physical activity and decreased anxiety and depression scores. All in all, lower body weights at baseline for men were related to a decrease in caloric consumption from protein and greater occupational endeavors and for women, higher educational status. Obesity is also found to be most prevalent among women from urban areas and appeared to decrease as age increased (Lerman-Gamber et al. 1999). Thus, the effect of demographic variables such as gender, education status, and age factors on obesity should also be subjects of interest in future research.

REFERENCES


