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DISSERTATION

An International Comparison of Obesity in Older Adults

Effects and Risk Factors

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This document was submitted as a dissertation in August, 2006 in partial fulfillment of the requirements of the doctoral degree in public policy analysis at the Pardee RAND Graduate School. The faculty committee that supervised and approved the dissertation consisted of Emmett Keeler (Chair), Roland Sturm, and Neeraj Sood.

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Abstract

This dissertation examines two issues related to obesity in older Europeans. First, it evaluates the effects of excessive body weight on health, utilization of medical care and labor force participation among older populations in Europe, and compares the effects across the different nations. Second, it analyzes risk factors for obesity and their interactions with environmental and societal variation across European countries. The dissertation concludes with a review of strategies and approaches for the prevention and management of obesity through public policy. Practices and experiences in different countries are examined along with an analysis of institutional structure, participants, functions, and areas of action in policymaking concerned with obesity control.

Drawing from nationally representative samples of the non-institutionalized population aged 50 and above in ten European countries, I find that obesity is associated with significantly poorer health, medical care and employment outcomes with effects similar across countries. Obesity has stronger links to labor force participation among women, especially for retirement. About one tenth of disease prevalence and ill health can be explained by obesity, which exceeds the contribution of risk factors like smoking and aging.

Lack of regular physical activity is associated with higher obesity rates, particularly among women. The difference in predicted obesity rates between least and most physically active women is almost double, with substantially lower obesity even from moderate-intensity physical activity. The mechanism of the food-related weight gain is likely to differ between many European populations and the U.S., as the obese in Europe eat primarily at home. Low education explains about one fifth of obesity

prevalence in women and one-sixth in men, exceeding the attendant contributions of other behavioral and societal risk factors. This study found no evidence that institutional and cultural differences across European nations attenuate or exacerbate the effect of SES or physical activity on obesity.

One of key elements of any preventive strategy for obesity is health education and health promotion. Another important tool for government intervention is economic policy that uses taxes/ subsidies and regulation of production to improve social welfare. Policies on obesity worldwide have moved away from using the approaches focused exclusively on health education or the individual awareness approach towards addressing the environmental factors of obesity. Market failures like externalities of obesity and incomplete information invite government action to address the obesity problem, yet areas of action are multiple, intervention effectiveness are uncertain, which calls for further extensive research on obesity.

CHAPTER 1 – Introduction

This dissertation examines two issues related to obesity in older Europeans. First, it evaluates the effects of excessive body weight on health, utilization of medical care and labor force participation among older populations in Europe, and compares the effected responses across institutionally and culturally different nations. Second, it analyzes risk factors for obesity and their interactions with environmental and societal conditions across European countries. Policy implications of both studies are summarized in a review of public health policy for obesity across countries.

The first study explores the relationship between obesity, health, utilization of medical care and labor force participation. The link between excessive body weight and health is an important concern for public health policy around the world because obesity has considerable implications for morbidity and quality of life of obese individuals, and an attendant increase in health care costs. Obesity may also influence labor force participation through poorer health and weight discrimination. A potential shrinkage in the labor force is a worrisome trend for social security in Europe, which is already facing serious concerns about the systems financial viability, as well as in the U.S., which will run into similar issues as baby boomers retire.

The study population of adults aged 50 and older is of keen interest from a policy perspective as it will be a long-time beneficiary of public programs already paying for a substantial part of costs related to obesity. This focused study can help more accurately predict the health risks of obesity at older ages that would be of interest to public ad private health plans. The analysis is one of few to apply a cross-national perspective to the study of obesity risks, and the first to do so for older adults. Despite the potential of

comparative analysis to learn from institutional, cultural and socio-demographic differences across countries, multinational comparisons of obesity remain scarce and entirely missing for the elderly.

The second study analyzes risk factors for obesity among older population in Europe. Understanding the causes of excessive body weight gain is essential for public health policy to design programs that could help prevent the further spread in obesity, and attenuate the negative consequences of obesity for public welfare. Obesity is likely to be avoided through behavioral changes and lifestyle choices, which rational agents undertake if the expected benefits exceed costs. The key factors contributing to the development of obesity are modifiable, and may be addressed through changes in incentives led by policy initiatives.

Whereas there is a substantial body of research on the role of genetic, behavioral, societal and environmental factors and their interactions for the growth in obesity in the U.S., such data for other nations are more limited. As the weight distributions are different between the U.S. and Europe, the patterns of obesity established in the U.S. could diverge from those in European nations. Institutional variation across countries is also substantial, which may have different implications for the magnitudes of risk factors and the groups affected. It is also unknown whether there is significant variation in the effects of risk factors associated with obesity across nations.

Objectives

This dissertation is designed to achieve the following objectives:

1. To examine whether obesity affects negatively health, utilization of medical care and labor force participation among older Europeans:

2. To identify and measure risk factors for obesity in adults aged 50 and above:
3. To explore policy responses to the growth of obesity in selected European countries and the U.S.:

Policy Relevance and Contribution to Knowledge

This study makes a number of contributions. First, the research fills a gap in the obesity literature by generating nationally comparable estimates of the effects and risk factors associated with obesity in older Europeans. Using a rich dataset of nationally representative data from ten countries, it shows that obesity is related with significantly poorer health, medical care and employment outcomes among older adults. Strong effects of obesity on labor force participation in women are another important message for labor and ageing policy. The study findings on the persistence of obesity effects on health and employment across European nations, and greater contribution of obesity to ill health relative to other behavioral risk factors underscore the importance of obesity concerns for public health policymakers. Second, this study provides estimates of the risk factors for obesity in older adults, and compares the effects across countries to determine whether institutional, social and economic differences modify the gradients. Education plays a key role in explaining differences in obesity, yet behavioral factors like physical activity are very important as well. These factors can be modified through changes in incentives and information, and may be more responsive to policy initiatives than are structural factors like education or income status.

CHAPTER 2 - The Effects of Obesity on Health, Medical Care Use and Labor Force Participation Among Older Europeans

1. INTRODUCTION

This study examines the relationship between obesity, health, utilization of medical care and labor force participation. The link between excessive body weight and health is an important concern for public health policy around the world because obesity has considerable implications for morbidity and quality of life of obese individuals, and an attendant increase in health care costs. Obesity may also influence labor force participation through poorer health and weight discrimination. Early retirement or claiming disability benefits due to obesity-related health conditions illustrate how obesity may reduce labor supply and increase pressure on the sustainability of pension provisions. A potential shrinkage in the labor force is a worrisome trend for social security in Europe, which is already facing serious concerns about the systems financial viability, as well as in the U.S., which will run into similar issues as baby boomers start to retire.

I focus on adults aged 50 and older. For a number of reasons - the biology of aging, age-related changes in physical activity and caloric consumption - the health effects of obesity probably vary over the life cycle. They are more likely to develop in middle age (Mokdad et al. 2003). Given the differential effects of obesity over the lifetime, generalizations from the overall population may be inaccurate for predicting health consequences of obesity in older adults. At the same time, understanding the

effects of obesity on health and related outcomes among middle age individuals and the elderly is important because this population will be a long-time beneficiary of public programs that already pay for approximately half of medical expenditures attributable to overweight and obesity in the U.S. (Finkelstein et al. 2003). As a consequence, an older population is of keen interest from a policy perspective. The available data on obesity implications for mortality and morbidity among older adults is however inconclusive, particularly for longevity among the obese elderly (Andres et al. 1993, Lakdawalla et al. 2005, Olshansky et al. 2005, Peeters et al. 2003, Willet et al. 1999). This focused study can help more accurately predict the health risks of obesity at older ages that would be of interest to public and private health plans.

This analysis is one of few to apply a cross-national perspective to the study of obesity risks, and the first to do so for older adults. Despite the potential of comparative analysis to learn from institutional, cultural and socio-demographic differences across countries, multinational comparisons of obesity remain scarce and entirely missing for the elderly. Little is known about the extent to which institutions and social norms could modify the effect of obesity on health and employment outcomes. Obesity patterns outside the U.S. and their comparison to the trends in America are also a scarce subject in earlier research. My study aims to reduce this gap in knowledge. Using comparable data from ten European countries I estimate the link between obesity, health and employment outcomes for older adults, explore differences in the obesity-health/employment gradient across countries, and decompose the contribution of obesity to disease and health disparities across countries.

Another novelty of this research is in modeling non-linearity in the effects of obesity on health along with gender differences in the measurement of obesity. Although the need to consider nonlinearities in the disease response to changes in body weight is apparent from the growing clinical evidence (NIH 1998), most epidemiological and public health research has aggregated obese individuals in one group (BMI $\geq$ 30 kg/m^2). Large differences in health and health care outcomes by degree of obesity are hidden in such aggregations, and do not allow us to accurately predict outcomes both at the individual and societal level (Sturm et al. 2004, Andreyeva et al. 2004).

That men and women may have different thresholds for healthy weights was acknowledged in most dietary guidelines till the mid-1990s when the Department of Health and Human Services (1995), the WHO Consultation on Obesity (1997) and the NHI Expert Panel (1998) substituted the gender-specific criteria with universal ones (Kuczmarski and Flegal 2000). Concerns have been raised since then about the accuracy of using the same BMI criteria in men and women. Similarly, it has been argued that the conventional measurement of overweight and obesity is inaccurate for some ethnic groups, primarily Asians. In this respect, the Asia-Pacific Group of the World Health Organization proposed classification of weight by BMI in adult Asians using lower BMI cut-offs: BMI $\geq$ 23 kg/m^2 to define overweight, BMI $\geq$ 25 kg/m^2 for obesity and BMI $\geq$ 30 kg/m^2 for severe obesity (WHO 2000). This analysis explores implications of alternative measurement of overweight and obesity in men and women for estimating the health and societal consequences of obesity.

The study examines the relation of obesity to health, use of medical care and labor force participation using nationally representative samples of the non-institutionalized

population aged 50 and above in ten European countries. The data are from the Survey of Health, Ageing and Retirement in Europe (SHARE), a multidisciplinary and cross-national study that collected data on health, socio-economic status, economic well-being, social and family networks for 22,777 individuals in 2004. This research is designed to answer three questions: (1) Does obesity imply significant risks for health, increased utilization of health care services and reduced labor supply after the age of 50, and what are the magnitudes of the associated risks and most affected groups? (2) Does obesity have similar effects on health, medical care and employment outcomes across European countries? (3) What is the contribution of obesity to health disparities across countries?

I estimate multivariate regression models of the association between obesity, health, utilization of medical care and labor force participation using a pooled sample of all participating SHARE countries and individually by country. I fit logistic regression models for dichotomous health outcomes, a two-part model for health care outcomes with a large share of non-users (inpatient health care), a linear model for continuous outcomes with few non-users (outpatient visits), and a maximum-likelihood multinomial logistic model for the labor force status.

The findings suggest that obesity is strongly associated with major health risks for older Europeans. The odds of chronic health conditions (chiefly diabetes and hypertension), disability and poor self-reported health are much higher for obese men and women than for normal weight people. Particularly high risks of disability and impaired health among older people, especially women, are related to severe obesity. The adverse health consequences of excessive body weight are independent of the health decline related to physical inactivity. Increased morbidity among the obese is reflected in

significantly higher utilization of outpatient health care services. The association of obesity with reduced employment is strongest for severely obese men and women. Retirement is related to obesity only in women. The results are robust across countries, socio-demographic groups and model specifications of obesity.

The health and employment effects of obesity do not vary significantly across European countries. Whereas country-specific factors like generosity of health insurance, health care productivity, behavioral factors or geography could modify the effect of obesity on disease, health care and labor supply, the evidence for such trajectories cannot be found in this study. Obesity appears to be a universal phenomenon whose adverse effects on health and related outcomes withhold social and environment differences across nations and sub-populations. At the same time, relative similarity of the populations and environment of neighboring European countries in this study and limited statistical power may be partially responsible for the observed lack of variation in the obesity-health/labor supply gradient throughout Europe.

Finally, the contribution of obesity to health impairments exceeds the effects of smoking, problem drinking or a decade of aging. Obesity explains on average about ten percent of the country prevalence of disease, varying from less than 5% for depression to almost a quarter of diabetes rates. In contrast, 10-year aging from age 50 to 60 accounts for about 5% of rates of poor health, and the contribution of smoking is even lower. Large disparities in health across countries remain after adjustment for national differences in obesity rates.

The remainder of the paper is structured as follows. Section 2 provides further background and a discussion of the literature. Section 3 describes the analytical strategy

and the SHARE data, including the specific estimation sample and variables used. Section 4 presents results of the analysis. The concluding Section 5 summarizes the findings.

2. BACKGROUND AND LITERATURE REVIEW

The obesity epidemic has received considerable attention worldwide. Numerous studies have documented that obesity, defined as BMI of 30 kg/m^2 or more, is climbing around the world. Obesity rates have been rising in virtually all population groups, regardless of the demographic or socio-economic status (Flegal et al. 1998, Flegal et al. 2002, Mokdad et al. 1999, NCHS 2000, Ogden et al. 2002, Truong and Sturm 2005, WHO 2000). The growth in the population fraction with unhealthy body weight was particularly high in the U.S., but it has reached worrisome proportions in other developed and developing countries as well (WHO 2002). The prevalence of obesity in U.S. adults more than doubled between the mid-1970s and late 1990s with the most dramatic growth occurring in the 1980s (Flegal et al. 2002). It increased more than three-fold among children and adolescents over the same period (Ogden et al. 2002). As a result, two-thirds of U.S. adults aged 20 years and older are now either overweight or obese (BMI of 25 kg/m^2 and above) based on measured weight and height. More than 1 in 5 adult Americans (22.1% in 2002) are classified as obese based on self-reported weight/height, and 1 in 3 (32.2% in 2004) based on objectively measured data (BRFSS 2002, Ogden et al. 2006). Worldwide, the estimated number of overweight adults exceeds one billion, of which at least 300 million qualify as obese (WHO 2002).

Effects of Obesity on Health

The spread in obesity is troubling because obesity is associated with increased morbidity and mortality. Its adverse health consequences may exceed those of smoking or alcohol abuse (Sturm 2002). A growing pool of clinical and epidemiological studies has provided evidence on the adverse health effects of human adiposity. Obesity is an established risk factor for many prevalent, mortality-driving and costly chronic conditions like cardiovascular diseases, type 2 diabetes, hypertension and some types of cancer (breast in postmenopausal women, endometrial and colon). Other medical conditions related to overweight and obesity include gastrointestinal diseases, sleep apnea and respiratory problems, osteoarthritis, low back pain, metabolic syndrome, reproductive hormone abnormalities, and various psychological consequences such as poor self-esteem, depression, body dissatisfaction, and psychological discomfort (Field et al. 2001, NIH 1998, Mokdad et al. 2003, Must et al. 1999, WHO 2000).

One concern about epidemiological studies in this area is that they often give the average level of risk associated with overweight or obesity rather than the odds of disease for population sub-groups. Those may vary by race/ethnicity, gender, age and social status. For example, the absolute risk of coronary heart disease (CHD) is the highest in the elderly, but the relative risk of CHD due to obesity is peak in middle age (Feinleib 1985, Garrison et al. 1985, Rabkin et al. 1977). The relative risk of hypertension and CHD attributable to obesity varies by race/ethnicity but it is the same across all groups for diabetes (NIH 1998). Smaller samples for subpopulations are often responsible for shortage of detailed risk estimates in the literature.

Another limitation of many epidemiological studies is reliance on self-reported weight and height data, which have notorious inaccuracies that understate weight and overstate height to a varying extent across demographic groups (Ezzati et al. 2006, Kuczmarski et al. 2001, Palta et al. 1982, Rowland 1990). Not all studies are also careful about the causal interpretation of the risk due to obesity for conditions like depression, back pain or disability, which may reflect the causal pathways in either way. For example, obesity may lead to depression whereas depressive mood may promote weight gain, so simple correlations indicate both effects (Faith et al. 2002, McElroy et al. 2004).

Prior research has shown that there are large differences in disability and health care costs by degree of obesity, often exceeding those between the average obese (BMI $\geq$30 kg/m^2) and normal weight person (Sturm et al. 2004, Andreyeva et al. 2004). Severe obesity is associated with more health problems than moderate obesity and the onset is at earlier ages (Field et al. 2001, Hillier and Pedula 2001, Must et al. 1999). The mortality risk attributed to obesity also appears to vary across obesity groups (Krueger et al. 2004, Thorpe and Ferraro 2004). Finally, there are substantial differences in growth rates of obesity by degree of excessive body weight. For example, the prevalence of extreme obesity (BMI $\geq$ 40 kg/m^2) quadrupled between 1986 and 2000 while the prevalence of average obesity (BMI $\geq$ 30 kg/m^2) approximately doubled (Sturm 2003).

Financial Effects of Obesity

Through the increased risk of adverse health conditions and work disability, obesity expands the financial burden of public transfer programs and private health plans. The costs are considerable. At the individual level, obesity is associated with health care

expenditures that are on average about one-third above medical costs of otherwise similar individuals with normal weight (Finkelstein et al. 2003, Lakdawalla et al. 2005, Sturm 2002). At the aggregate level, obesity-related direct and indirect economic costs exceed $100 billion per year (Wolf and Colditz 1998), and the number is expected to grow. In relative terms, obesity accounts for about 6-10% of U.S. health care spending (Colditz 1999, Finkelstein et al. 2003, Wolf and Colditz 1998) and 2.0-3.5% in other Western countries (Birmingham et al. 1999, Levy et al. 1995, Schmid et al. 2005, Swinburn et al. 1997). In the U.S., the burden of obesity-attributable costs falls disproportionately large on public health care, draining out resources of public programs like Medicare and Medicaid (Finkelstein et al. 2003). The dynamic estimates describe the cost implications of obesity in a similar fashion, suggesting that obesity accounts for 27% of the growth in real U.S. health care spending over 1987-2001 (Thorpe et al. 2004). The full effects of obesity trends since the 1980s are yet to be apparent at the aggregate level due to a time lag between weight gain and emergence of health problems at the individual level.

Whereas the cited estimates provide the scope of total costs associated with obesity, economists generally focus on external costs, which are the consequences of individual decisions imposed on others. For example, secondary smoking or drunk driving presents health risks not only to the agents themselves but also to individuals surrounding them. External costs of such activities, as well as those of sedentary life and other poor habits, are a substantial burden on society (Keeler et al. 1989, Manning et al. 1991). Arguably, the social burden of external costs is a more appropriate justification for policy action, such as tobacco and alcohol taxes. Economic theory suggests that policy interventions can improve public welfare if external costs are high. This appears to be the

case for obesity. The key mechanism through which obesity is responsible for notable external costs is pooled health insurance, estimated to induce about $150 per capita loss in public welfare attributable to obesity (in 1998 dollars) (Bhattacharya and Sood 2005).

Effects of Obesity on Employment and Wages

Several previous studies have demonstrated why the link between obesity and labor force participation has a perspective for research and relevance for policy. Domains of the labor market outcomes related to obesity include employment, wages/earnings and sector of occupation. Cawley used an instrumental variable analysis to find that there is no effect of weight on the probability of employment and employment disability but instead the observed correlation between employment disability and body weight is due to disability causing weight gain (Cawley 2000a). In a similar fashion, obesity appears to have no effect on unemployment. For example, obesity in adolescence does not predict a long history of unemployment at age 31; conversely, a long history of unemployment increases the risk of obesity at age 31 but only among women (Laitinen et al. 2002). Several earlier studies report that obesity is related to lower wages among women but no earnings-depressant effect due to obesity can be identified for men (Loh 1993, McLean and Moon 1980, Pagan and Davila 1997). Others suggest that both obese men and women receive a wage penalty, which is almost twice higher for women – a difference of 6.1% vs. 3.4% in wages of obese and non-obese women and men (Baum and Ford 2004). Only white women are found to have lower wages due to obesity in another study (Cawley 2000b, Cawley 2004). Yet the direction of causality is not definitive, as low wages may cause obesity or unobserved factors increase weight and lower wages.

Several explanations are suggested for the wage penalty results, varying from weight discrimination to lower productivity of obese people (Averett and Korenman 1996, Cawley 2000a, Puhl and Brownell 2003). The role of weight discrimination in employment is a particularly well-documented issue. Weight-based discrimination in employment settings is broadly characterized into hiring prejudice and inequity in wages, promotions and employment termination (Puhl and Brownell 2001). A number of experimental studies addressing stereotypic attitudes in employers established that bias against hiring overweight (especially female) job applicants exists (Klassen et al. 1993, Pingitore et al. 1994, Rothblum 1992). Numerous work-related stereotypes assume obese employees as lacking self-discipline, lazy, less competent, disagreeable, and slow (Roehling 1999). Affecting particularly women, these stereotypes take a form of a significant wage penalty, lower promotion prospects and benefits, in some cases suspension due to weight (Loh 1993, Rothblum et al. 1990).

Another important societal outcome of obesity is disability. Some researchers suggested that declines in disability over the next 15 years might cease or reverse due to obesity-related morbidity (Sturm et al. 2004). This concern is already evident from the cross-cohort analysis of disability rates. When the prevalence of disability in the elderly remained constant or declined since the mid-1980s (Manton et al. 1997), younger populations, especially aged 30-49, have observed increasing disability rates (Lakdawalla et al. 2004). The available data is still insufficient to give definitive conclusions about the role of obesity in increasing disability among younger cohorts. Predictions are hard due to the counteracting effects of other societal changes. The existing forecasts suggest that

future disability rates among middle age individuals may increase one percent annually, assuming continuing weight gain (Sturm et al. 2004).

Obesity in Older Adults

Obesity is a particular concern in older adults because the health effects related to excessive body weight are more likely to develop in middle age. Studies in the younger population are unlikely to capture all health risks related to obesity, as they are not yet apparent in the younger obese. Another reason to focus obesity research on older adults is that many of today's obese are in their 50's and 60's (Flegal et al. 2002, Mokdad et al. 2003). Older adults are also unlikely to have major changes in weight by the end of life except before death or/and in cases like cancer. From a policy perspective, the older population is important for understanding the risks related to obesity because they have direct implications for social transfer programs.

Cross-sectional and longitudinal relationships between obesity and health at older age recently received increasing attention in the academic and policymaking world. There is growing evidence that the prevalence of poor physical functioning, chronic health conditions and functional limitations is higher among older adults with excessive body weight (Himes 2000, Jensen and Freedman 2002, Jenkins 2004). Obesity also emerges as a risk for increased mortality after the age of 50, although the effects are indirect and appear to work through the link of obesity to chronic diseases (Thorpe and Ferraro 2004). When examining mortality implications of overweight at older ages, researchers generally find that overweight but not obese individuals have lower overall mortality risk (Krueger et al. 2004, Thorpe and Ferraro 2004). Future research will need to investigate

whether overweight status may have a protective effect for mortality in later life. This research would also need to explore how mortality effects differ across subgroups of the overweight population, including obese who lost weight and moved to overweight fairly recently, people who remained in the overweight category for a long time, and normal weight persons who gained weight and stayed overweight for a short period of time.

Little is known about differential effects of obesity on health and employment across socio-demographic groups among older adults. Primarily as a consequence of scarce data for subpopulation groups, obesity research has not really focused on socio-demographic differences in the older population but only included related backgrounds as controls in estimations. Whether the role of education, income and race/ethnicity in the BMI-health gradient among the elderly is as important as in the general population remains an open question for research. Furthermore, gender differences in how obesity affects health in older people are also poorly understood. For example, many nonfatal yet disabling conditions like osteoporosis, back problems, osteoarthritis and depression are more prevalent among women, contributing to greater disability and diminished quality of life of women compared to men (Murtagh and Hubert 2004). Obesity elevates the risk for the onset and severity of these conditions and may therefore be particularly detrimental to women's health and functional ability.

International Comparisons

In the international literature on obesity, the WHO MONICA study has provided the most comprehensive data on the global prevalence of obesity (Tunstall-Pedoe et al 2003). This world's largest study of heart disease, stroke, risk factors and population

trends over 1979-2002 collected data in a large number of countries over the same time period and used identical protocols for measuring body weight and height (WHO 2000). There are important concerns about obesity estimates from this source. First, the surveyed populations were not necessarily representative of the countries, in which they were located, and generalizeable conclusions are therefore impeded. Second, the samples were often limited to ages 35-64 (when the study age range was 25-64) precluding analyses for the elderly. Finally, the latest BMI estimates were available for 1996, which by now are a decade old. Given obesity trends worldwide, the MONICA estimates may already be out-of-date and underestimate the actual prevalence of obesity.

Other studies include cross-national comparisons of obesity in adults aged 15-75 using data from the European Community Household Panel for nine member states of the European Union (EU) (Sanz-de-Galdeano 2005) and estimates for the adult population (age 15+) in 15 EU countries (Martinez et al. 1999). Drawing from self-reported weight and height data, both studies gave obesity rates across European countries and explored correlates of excessive body weight. In addition to standard socio-demographic factors, the first study considered how obesity was related to the demand for outpatient health care services and work absenteeism. As the survey lacked information on any chronic health condition, disability, costs of medical services or inpatient health care, the study was limited in the scope of potential outcomes to explore. The second EU study extended socio-demographic correlates of obesity with behavioral factors (smoking and exercise).

This study contributes to the literature along several dimensions. First, I provide nationally comparable estimates of the prevalence of obesity and related chronic health conditions in the European older population that till now have not been available. This

analysis is based on nationally representative large samples that produce generalizeable and less noisy estimates. Second, I examine the consequences related to obesity not only for health but also for societal outcomes like disability and employment. Furthermore, I compare the health and social effects of obesity across countries and explore factors related to potential differences in the gradient. Finally, I estimate the contribution of obesity to disease and health disparities across European countries.

4. DATA AND METHODS

The data come from the Survey of Health, Ageing and Retirement in Europe (SHARE), which collected information on nationally representative samples of the community-based population ages 50 and older in Continental Europe. The baseline 2004 SHARE study included data on 11 countries that featured a balanced representation of the different European regions from Scandinavia (Denmark and Sweden) through Central Europe (Austria, France, Germany, Switzerland, Belgium, The Netherlands) to the Mediterranean (Spain, Italy and Greece). This study uses data from the 2004 SHARE sample (Release 1 of April 28th, 2005) that included all participating countries with the exception of Belgium. Data collection in Belgium was completed after April 2005, and its sample will be available in the 2nd data release (scheduled for the fall of 2006).

The key advantage of this cross-national data set is that it provides nationally comparable information on Europeans over the age of 50 and their spouses that was collected in all countries following a standard protocol and research design. The SHARE data also contains detailed information on many different aspects of older individuals'

lives that few other large data sets have. These include health (e.g., self-reported health, grip strength, physical and cognitive functioning, health behaviors, health care use), psychological conditions (e.g., mental health, well-being, life satisfaction), socio-economic status (e.g., work activity, job characteristics, wealth and consumption, housing, education), and social support (e.g., social networks, volunteer activities). Designed after the role models of the US Health and Retirement Study (HRS) and the English Longitudinal Study of Ageing (ELSA), SHARE will be collecting data on older individuals over time. This paper uses data from the first wave in 2004. The longitudinal aspect of SHARE will be valuable for research as more waves become available.

The survey was administered as computer assisted personal interviewing (CAPI) among participants drawn from probability samples in all participating countries. The sampling plan followed a complex probabilistic multistage design to produce estimates representative of the non-institutionalized population aged 50 and above in each country. The response rate varied by country but on average was 57% for households and 86% for individuals within participating households. A detailed description of the SHARE data and methodology is available elsewhere (Borsch-Supan et al. 2005).

The major limitation of the data employed in this study is its cross-sectional nature. This data aspect essentially precludes any causal interpretation of the links between obesity, health and labor force participation. To identify and evaluate specific causal mechanisms and design effective interventions based on the evidence, longitudinal data is necessary, yet it is often limited or unavailable for sub-populations like cross-national comparisons of older adults.

Another data-related concern is missing responses on selected variables for some participants. Non-responses are important because if there is a systematic trajectory in why people refuse to answer some questions, the estimates generated using such a sample might be biased. The main source of missing responses on independent variables (N=683 or 3% of the original sample) is the unavailable data on body weight and/or height (N=645) so that construction of BMI and obesity indicators is not possible.

I compared observable characteristics of individuals with missing BMI with those who reported their body weight and height. Older, female, less educated, wealthy and healthy individuals are more likely not to have data on BMI. On the one hand, BMI is generally lower among older people and women. On the other hand, BMI is negatively correlated with education and income, so that the survey participants with missing BMI are likely to have on average higher BMI. The tendency of sicker people in the survey not to report weight has unclear implications for understanding their actual weight. The sick, particularly those suffering from cancer and before death, often lose weight, but at the same time poor health may be a consequence of excessive body weight. It is unclear how the missing BMI data could affect the weight distribution in the survey; so that excluding respondents with missing BMI should not bias the estimates of obesity prevalence.

Because the BMI variable is key to my analysis, I drop these cases (N=223). After doing so, 3 observations are missing because of education data. The number of missing responses for other independent variables (N=38) is too small to influence estimates in a systematic way. Furthermore, their mean BMI is not significantly different from the mean BMI of individuals with complete demographic data. In addition to the missing data on predictors, there were 326 individuals that did not have information on key dependent

variables, like labor force status, health and health care measures. There is no significant difference in the mean BMI of individuals with complete and incomplete data on the dependent variables. Hence, excluding such data from the analysis should not systematically affect the study results.

A further limitation of SHARE is that body weight, height and health conditions are self-reported. Several US studies show that individuals with excessive body weight tend to underreport their weight (with an increasing extent among the more obese). In addition, respondents often overestimate height, particularly in older population groups (Kuczmarski et al. 2001, Palta et al. 1982, Rowland 1990). So the estimates based on subjective assessment of body weight and height are likely to underestimate the actual prevalence of obesity in the participating SHARE countries.

The 2004 SHARE Release I sample included 22,777 respondents from 10 European countries. I impose several restrictions on the sample used for analysis. First, I exclude respondents younger than the age of 50 who are typically spouses of the primary respondents (759 observations or 3.3% of the original sample). The second exclusion (1009 observations or 4.4% of the original sample) is for data with missing responses on predictors and key outcomes, as discussed above. Due to these selections 21,009 individuals remain eligible for the analysis (9,652 men and 11,357 women).

Outcomes

There are three domains of outcomes in this study: health, utilization of health care and labor force participation, all evaluated at the respondent level.

Health Outcomes: The vector of health outcomes is three-fold and includes self-assessment of general health status, chronic health conditions, and emotional health. The

measure of overall health is based on subjective evaluation of health by respondents, which they reveal in answering the survey question "Would you say your health is excellent, very good, good, fair, or poor?" Collapsing responses, I construct an indicator for fair or poor self-reported general health vis-à-vis better health.

Among the reported health ailments, I examine five chronic health conditions that have well-established links with obesity in the literature. These are doctor-diagnosed chronic diseases, which are self-reported in the survey question: "Has a doctor ever told you that you have any of these conditions…" such as 1) diabetes or high blood sugar (the type of diabetes was not assessed); 2) cardiovascular disease (a heart attack, including myocardial infarction or coronary thrombosis or any other heart problem, including congestive heart failure), 3) high blood pressure or hypertension, 4) high blood cholesterol, and 5) arthritis, including osteoarthritis or rheumatism." I construct five indicators for these chronic health conditions.

Finally, I use the depression scale EURO-D to evaluate how obesity is related to emotional health or depression. The EURO-D depression scale, validated in an earlier cross-European study (Prince et al. 1999a, Prince et al. 1999b), is based on categorical responses about individual experiences of emotional problems in the month before the interview. The twelve feelings include sadness or depression, pessimism, suicidality, guilt, sleep trouble, interest, concentration, appetite, irritability, fatigue, enjoyment, and tearfulness. The threshold for depression is scoring 4 and above on the EURO-D scale.

As an alternative measure of depression in sensitivity analyses, I use an indicator for self-reported lifetime depression, which is suffering from symptoms of depression that lasted for at least two weeks at any point in one's life. Although the prevalence of

depression based on the EURO-D scale and self-reports is on average almost identical (27.3% vs. 27.0%), there is substantial (perhaps culturally-driven) variation across countries. Significantly more respondents in the Mediterranean countries qualify as depressed on the EURO-D scale than what is apparent from self-reports. In contrast, people in the Nordic countries more often report lifetime depression than what would be interpreted from the EURO-D scale. I consider two measures of depression to account for potential cross-country differences in response scales and cultural norms.

Health Care Outcomes: I use two variables to measure health care utilization. The first indicator evaluates outpatient health care and is based on the reported number of doctor visits over the 12 months before the interview (the survey recall timing). Like the analogous items in other household surveys, this measure excludes dentist visits and hospital stays but includes emergency room and outpatient clinic visits. As the majority of this older sample has at least one doctor visit over the analytic period (88.3%), I focus only on the intensity of outpatient services.

The second measure of utilization reflects inpatient health care, as indicated by the number of hospital nights in medical, surgical, and psychiatric or any other specialized wards during the 12 months before the interview. Unfortunately, use of specific services most probably reflecting disability is too small to include them as outcomes: for example, home care for nursing or personal care (3.9% of the sample) and permanent or temporal use of nursing home facilities (<1.2%).

The SHARE data on medical costs does not enable analysis of the relationship between obesity and health care expenditure. The survey provides only out-of-pocket health care payments whereas data on total health care costs are not collected. Out-of-

pocket payments are unlikely to capture fully the financial burden associated with obesity. The importance of out-of-pocket health payments varies across the SHARE countries from about 10% (France, Germany, Netherlands) to 20-25% (Austria, Spain, Italy) and top at 33% of all medical expenditures (Switzerland) (OECD, 2003). I consider the expenditure data only in sensitivity analysis. I estimate total out-of-pocket medical payments as well as out-of-pocket expenditure by type of service use like inpatient care, outpatient care and prescription drugs.

Labor Force Participation Outcomes: The primary measure of labor force participation is current job status. I define the employment status of the participants according to their selections of one of the six categories describing the current job situation: retired, employed or self-employed (including working for family business), unemployed, permanently sick or disabled, homemaker, and other. The majority of responses to the "other" employment status qualify as one of the primary five categories. I recode such cases according to the most appropriate job status and drop instances that do not fit any of the five categories (136 observations). I also validate the job status data by responses to a set of employment-related questions such as "In your main/secondary job are you an employee, civil servant or a self-employed?" For respondents who do not specify their occupation in the job status question, yet indicate employment in other survey questions, I use the latter to identify such respondents as employed.

To account for all types of occupation, I consider five categories of the job status in multinomial logistic models. This exercise is important because social transfer programs like unemployment- and disability-related social schemes are de facto used as an early retirement device in some European countries. The role of such schemes for

exiting the labor force varies across countries from virtually non-existent in some nations (e.g., Switzerland and Italy) to very important in others (e.g., disability schemes in the Netherlands, unemployment schemes in Germany and France). As sensitivity analysis, I use a set of dichotomous measures such as an indicator for retirement vis-à-vis employment or self-employment, and an indicator for disability relative to employment.

Explanatory Variables

The independent variable of key interest is a measure of relative body weight. Individuals are classified into weight categories based on their BMI calculated from self-reported weight and height. I explore two approaches to modeling obesity: a conventional definition based on standard BMI groups and exploratory categorization of gender-specific narrow BMI groups according to the relationship between health and BMI.

A conventional way to measure obesity is based on the clinical guidelines for the classification of overweight and obesity in adults, published by the National Heart, Lung and Blood Institute of the National Institutes of Health (NIH 1998). According to the NIH guidelines, individuals are stratified into six weight classes depending solely on their BMI: underweight (BMI<18.5), normal weight (BMI: 18.5-24.9), overweight (BMI: 25.0-29.9), moderate obesity (BMI: 30.0-34.9), severe obesity (BMI: 35.0-40.0), and extreme obesity (BMI: 40.0+). Much of the empirical work on obesity focuses on the aggregate group of adults with a BMI of 30 and above, which is a likely result of the paucity of data on very high BMI or the convenience of generalizing results for all obese. I separate the obesity group (BMI $\geq$ 30) into moderate (BMI of 30-35) and severe obesity (BMI $\geq$ 35) to account for non-linear effects of obesity on health. The sample size of

people with BMI ≥ 40 is too small to enable meaningful estimation. In the conventional specification of obesity I use five weight groups with normal weight as a reference group.

The exploratory modeling of obesity has more refined BMI criteria than conventional categories. They also vary by gender. I identify the appropriate BMI cutoff points in the analysis of BMI groups with a 2.5 BMI unit increase (e.g., BMI of 32.5-35). These are ranked on the health scale to select a BMI range with the most optimal health as a reference group. I compare estimates within standard BMI groups to test for non-linearity of the effects in each weight group. I assign men into one of the ten groups: BMI <18.5, BMI of 18.5-20, BMI of 20-22.5, BMI of 22.5-25 (a reference group), followed by BMI groups of 2.5 units up to BMI of 37.5 that includes men with higher BMI. Women are selected into one of the eleven BMI groups: BMI <18.5, BMI of 18.5-20, BMI of 20-22.5 (a reference group), followed by BMI groups of 2.5 units up to BMI of 40 that combines women with higher BMI.

A variety of individual level variables are included as controls in the estimation. A set of standard socio-demographic covariates has educational achievement (secondary and tertiary education, primary or no education is a reference group), marital status (married and living together with a spouse or registered partnership), and age. I include a vector of age groups with a five-year increment up to the age of 85 and above when modeling health (age 50-54 is a reference group). I use the same age groups as in health models, but collapse individuals aged 65 and older in labor supply models (65+ is a reference group). Another difference between health and labor force estimation is that I include household income estimated as an inverse of a hyperbolic sine of annual household income before taxation (Beyer 1987, Zwillinger 1995) in health and health

care models but exclude this potentially endogenous factor from labor supply models. Current and past smoking is controlled in all models.

Table 1 provides the means and standard deviations for the independent variables by standard BMI group and gender. The means and standard deviations for the outcomes across BMI groups are given in the Appendix Table A1 (men) and Table A2 (women).

Analytic Procedure

The analytic strategy I pursue is designed to ascertain how obesity is related to health and societal outcomes among Europeans aged 50 and above, whether the obesity-health/employment gradient varies across countries, and how much of health heterogeneity across countries is due to obesity.

The task of quantifying the association between obesity, health, medical care and labor force outcomes for an average older European is accomplished in the estimation of a set of models on a pooled SHARE sample. The rationale for first focusing on the average effects of obesity throughout the participating countries is two-fold: to estimate the mean consequences of obesity for health, health care and employment at older ages, and to identify the benchmark for cross-country comparisons. I do so by pooling the data across countries and conducting all analyses separately for men and women, as indicated from tests for interactions between BMI groups and gender. To account for the complex sampling design and obtain nationally representative estimates, I use individual sample weights when presenting sample statistics but not in regression analysis. The Huber/White nonparametric correction produces robust standard errors.

I use logistic regression to generate the odds ratio (ORs) for health indicators, disability and dichotomous employment outcomes across BMI groups. I model labor

force participation using all categories of the current occupation status and fit the data based on a multinomial logistic model. The number of medical visits is estimated in a linear regression, whereas Poisson and negative binomial models for count date are considered in sensitivity analysis (results not presented). To account for a large share of non-users of inpatient services in the sample (86%), I use a two-part model for the number of hospital nights. This model estimates the probability of service use in the first part (using a probit regression for any inpatient service use), and the intensity of utilization among users in the second part of the model (based on a log-linear model to address the skewness of data among health care users) (Duan et al. 1983, Duan et al. 1984). I use the two-part model for out-of- pocket health costs in sensitivity analysis.

To convert log estimates back to the numeric scale for the number of hospital nights, I use a nonparametric homogenous smearing retransformation (Duan et al. 1983). Earlier research showed that the homogenous smearing retransformation led to biased estimates of the response of interest when the log-scale residuals were heteroscedastic in a way that depended on the covariates (Manning and Mullahy 2001, Manning 1998). This issue does not appear problematic in my analysis because there is no heteroscedasticity by the variable of interest (BMI group) for a count of hospital nights ($p=0.24$ for men and $p=0.32$ for women, Breusch-Pagan/Cook-Weisberg test for heteroskedasticity).

In addition to the observable individual characteristics, I include country fixed effects in all models estimated on the pooled sample. They represent economic and social policies; legislative, cultural and medical practice norms that affect health, medical care and employment outcomes universally across all individuals within a country. In the sensitivity analysis of employment outcomes I use country-level employment policies.

These include measures of pension entitlements like relative replacement rates (pension benefits as a share of individual lifetime average earnings), net pension wealth (the expected present value of future pension benefits), pension level (pension benefits as a share of average economy-wide earnings), as well as non-pecuniary indicators of retirement policies, such as the effective age of retirement and exit age from the labor force (weighted by the probability of withdrawal from the labor force).

I check robustness of estimation results to the inclusion of physical activity in health and health utilization models. This exercise measures the effect of excessive body weight on health independent of physical activity. An exploratory analysis of obesity and labor force participation links considers the sensitivity of estimates to the inclusion of health controls in employment models. Along with financial incentives health plays a significant role in retirement decisions. In SHARE about 20% of retired men aged 60-64 and 14% of retired women of the same age give ill health as a reason for their retirement. After reaching the official retirement age (65 in most SHARE countries) about 15% of men and 13% women retire because of their poor health. However, it is a priori unclear whether health should be included in modeling the association between obesity and labor force participation. The primary mechanism through which obesity may affect employment is health. Therefore, correcting for health in the analysis of labor force participation and obesity may provide estimates that are downward biased. I explore this hypothesis by adding health controls that are not related to obesity but correlated with employment, such as cancer (all types but skin cancer), stroke and chronic lung disease.

I test for differential effects of age on health and employment outcomes across countries. The potential of age to affect unequally employment outcomes is

straightforward because national retirement policies are often linked to age. It is however less obvious whether age affects health and health care outcomes differently across countries. Physiology, genetics and the biology of aging are quite universal, particularly in a relatively close geographic area like Continental Europe. At the same time, national differences in social norms, health care systems and practice of medicine may affect the interaction between age and health/medical care. An example may include an inverse U-shaped relationship between age and health care costs in some countries (e.g., China), or a substantial decline in the incidence of cancer in the elderly (e.g., Russia). I test the hypothesis of differential age effects on health, health care and employment across countries by including interactions between age groups and country indicators, which turn out to be significant and included only in labor supply models.

In the second task of this study I test for differential effects of obesity on health, medical care and employment outcomes across countries. This analysis is completed in two steps. First, I estimate interactions between continuous BMI and country indicators to identify whether the slope of the obesity relation with health and employment varies across countries. To isolate the effect of very low BMI, which is often endogenous to poor health, I test BMI-country interactions in the sample with an increasing monotonic BMI-health gradient rather than a U-shaped function for all BMI. This excludes men with BMI below 22.5 and women with BMI below 20. Because they are probable data errors, I also drop observations with very high BMI levels (BMI>50) and explore a range of other sampling approaches (e.g., excluding top and bottom 1% of the BMI distribution). Tests between BMI group indicators and country dummies are also conducted as an additional check. Second, I estimate all models by country and compare country-specific estimates.

Large differences in the prevalence of chronic health conditions across countries can be decomposed into the specific causes of the cross-country variation using the decomposition technique (Blinder 1973, Oaxaca 1973). This method estimates separate contributions of group differences in measurable characteristics like socio-demographic and behavioral differences across countries. Differences in the outcomes across countries or population groups could be due to differences in unobservable characteristics or intercepts, effects of characteristics or regression coefficients, and observable characteristics or the population composition. I decompose the contribution of obesity to health using a decomposition method developed in Kapteyn et al. 2004. This estimates the total effect of obesity on disease as a product of the prevalence of obesity and the estimated disease risk due to obesity in that country (percentage difference between adjusted probability of disease for obese vs. normal weight people). The ratio of the total effect of obesity to the prevalence of disease in the country gives the contribution of obesity to the national rate of disease. In a similar fashion, I explore the role of obesity in health disparities across countries.

The following structural model presents the core analytic work in this paper. Consider an individual *n* in a country *c* and define the following quantities: a vector of chronic health conditions, ADL-disability and self-reported health (σ_{cn}), a vector of health care indicators (μ_{cn}), a vector of labor force categories (τ_{cn}), a respondent's BMI group (η_{cn}), a vector of individual socio-demographic characteristics (z_{cn}), income (y_{cn}), error terms (satisfying classical assumptions, distributed multivariate-normally) ε^{i}_{cn} (where the superscript indicates the equation), and parameters: $\alpha, \delta, \beta, \theta, \psi, \gamma, \lambda$. Note that all of the parameters are fixed across countries in the pooled sample analysis

assuming that cultural and social norms do not yield a different response to the same variables in different countries. This assumption is relaxed in the estimation of individual country samples.

With this notation consider the following general model:

$$\sigma_{cn} = \alpha + \delta\ \eta_{cn} + \beta\ z_{cn} + \theta\ y_{cn} + u_c + \varepsilon^h_{cn} \quad (1)$$

$$\rho_{cn} = 1 \text{ if } \mu_{cn} > 0$$
$$\rho_{cn} = \alpha_1 + \delta_1\eta_{cn} + \beta_1 z_{cn} + \theta_1 y_{cn} + u_c + \varepsilon^{\mu}_{cn} \quad (2)$$
$$\mu_{cn} \mid (\rho_{cn} = 1) = \alpha_2 + \delta_2\eta_{cn} + \beta_2 z_{cn} + \theta_2 y_{cn} + u_c + \varepsilon^{\mu}_{cn}$$

$$\tau_{cn} = \psi + \gamma\ \eta_{cn} + \lambda\ z_{cn} + u_c + u_c * a_{cn} + \varepsilon^{\tau}_{cn} \quad (3)$$

The first equation explains the health vector as a function of BMI, observable and unobservable individual characteristics including income (y_{cn}), social and economic policy in the country c (u_c), and an error term. A system of equations (2) models inpatient health care use in two stages: identifying the probability of a positive outcome and explaining the intensity of positive outcomes. Equation (3) specifies the labor force status as a function of the observable individual characteristics (except income), BMI, country fixed effects, their interactions with age groups (a_{cn}), and an error term.

4. RESULTS

The discussion of the study results is segmented by outcome domain into health, use of health care services and labor force participation. I continue a review of the results for the overall sample by presenting differences in the effects of obesity across countries and socio-demographic groups. Comparative analysis of the obesity gradient for health

and employment includes a discussion of these patterns in the U.S. Decompositions of the obesity contribution to disease and disparities in health conclude this section.

I will show that obesity is associated with significantly poorer health, medical care and employment outcomes among people aged 50 and above, and its risks are particularly high in the severely obese. The links to labor force participation outcomes are stronger among women, especially for retirement. The analysis finds no differences in how obesity is related to health, utilization of health care and employment across European countries. Obesity explains about one tenth of disease prevalence, exceeding the contribution of risk factors like smoking and aging. Health disparities across countries would remain significant if there were no variation in the prevalence of obesity.

Patterns in Obesity, Obesity-Related Health Conditions and Labor Force Participation

The prevalence of overweight and obesity in Europeans older 50 is high, particularly in some countries. On average, only a third of men (33.4%) qualify as normal weight, whereas more women (44.1%) are normal weight based on the standard BMI criteria. Among men with weight above normal, 13.3% are moderately obese and almost 3% are severely obese. For women, the prevalence rate is similar for moderate obesity (13.5%) and slightly higher than in men for severe obesity (4.3%). The socio-demographic profile of the BMI distribution is comparable to the patterns established in earlier studies and in the U.S. data, such as higher obesity rates among less educated and lower prevalence of obesity among current smokers (Table 1).

The rates of unhealthy body weight vary substantially across European countries (Table 2). Spain has the highest prevalence of obesity among men (20.2%) and women

(25.5%), and almost twice the rate of severe obesity among women than the sample average (7.4% vs. 4.3%, $p<0.01$). Men are least likely to qualify as moderately or severely obese in Sweden (12.8%) whereas for women this is true of Switzerland (12.3%, less than half of the obesity rate in Spain). Comparing the prevalence of normal weight men, the Nordic countries (Denmark and Sweden), the Netherlands and Switzerland have rates above the average ($p<0.01$). Normal weight women are more likely to live in the Nordic countries, Switzerland, France and less likely in Southern Europe ($p<0.01$).

Cross-country differences in the prevalence of obesity-related chronic conditions are also substantial (Table 3). Some of them may be related to the cross-country variation in obesity. For example, the prevalence of diabetes in Spain, the country with the highest obesity rates, is 14.3% for men and 13.1% for women. These rates are twice lower in Switzerland (7.2% men; 4.1% women), which is the country with the lowest prevalence of obesity. The link to obesity is less apparent for some other chronic health conditions. Cholesterol levels are often high in France, but the prevalence of obesity is relatively low in the country. Heart disease is most often reported in Sweden where obesity is not a prevalent condition. Cross-country differences in other risk factors and socio-demographic composition may account for the observed disparities in the rate of obesity and some chronic health conditions. For example, high rates of heart disease in Sweden most likely reflect an older sample in the country: the share of aged 75+ and 80+ Swedes is the highest in SHARE, whereas rates of heart disease are known to rise with age.

Labor force participation patterns are very diverse among older Europeans in different countries. Employment among the 60-64 year olds is illustrative of substantial cross-country differences in when and how Europeans exit the labor force. For example,

the percentage of retired men ages 60-64 in Austria is almost three-fold of the one among their peers in Sweden and Switzerland (85% vs. 30%) and two-thirds above the one in Germany and Spain (85% vs. 52%). The gap in retirement rates is striking given that these countries have the same standard retirement age of 65 for men. In a similar fashion, the percentage of 60-64 year-old men on disability in the Netherlands is about 15-17% when it is less than 1% in Italy or Greece. This gap most likely reflects institutional heterogeneity across European countries rather than actual differences in disability.

Relationship Between Obesity and Health

Rates of chronic health conditions, which increase with obesity, vary across BMI groups and severity of overweight (Appendix, Table A3). Regression analysis confirms descriptive results on obesity and health. As compared to normal weight people, men and women with BMI of 30 and above are significantly more likely to have adverse health outcomes like ADL-disability, major health conditions and poor general health (Tables 4-5). Severely obese women report poor or fair health status almost twice as often as women of normal weight (90%, $p<0.01$), which accords with estimates from earlier studies and the U.S. data (Field et al. 2001, Sturm et al. 2004). Among men, the most prevalent adverse self-reports of health are predicted in the underweight group (106% vs. normal weight, $p<0.01$). The estimates for ADL-disability reveal a similar pattern of the least healthy men among the underweight and the least healthy women among the severely obese. Another gender-related difference in the effect of excessive body weight on health is that overweight men report poor health as often as normal weight men (30.2% vs. 30.1%), whereas overweight is a significant risk factor for poor self-reported

health in women (38.8% vs. 33.8%, $p<0.01$). As apparent from the analysis of gender-specific BMI categories, the best health outcomes are at different BMI levels for men and women. For example, rates of ADL-disability and many chronic health conditions are the lowest for men with BMI of 22.5-25 and for women with BMI of 20-22.5 (Figure 1).

Both overweight and obesity are associated with chronic health conditions like diabetes, high blood cholesterol, hypertension and arthritis in men and women (Tables 4-5). Compared to older women of normal weight, women with BMI of 30-34.9 are three times more likely to have diabetes and almost twice as likely to report hypertension. The effects for men are somewhat smaller yet still substantial, for example, about 140% higher rates of diabetes and 96% of hypertension among moderately obese vs. normal weight men. Similar to earlier studies, this analysis reveals considerable differences in health risks related to excessive body weight by degree of obesity (Andreyeva et al. 2004, Field et al. 2001, Mokdad et al. 2003, Sturm et al. 2004). Individuals with BMI ≥ 35 kg/m^2 have notably higher odds than obese people with BMI of 30-35 kg/m^2 for all examined chronic conditions but heart disease in men, poor health and ADL-disability.

Differential effects of obesity on health along the gradient of overweight and obesity (BMI ≥ 25 kg/m^2) are particularly visible from the analysis that employs gender-specific narrow BMI groups. It reveals differences in risks of adverse health within standard obesity classes for virtually all examined health outcomes (Table 6-7). For example, the likelihood of diabetes among moderately obese women is predicted to increase 30% if their BMI falls within the second rather than the first half of the BMI 30-35 range (22% vs. 16.9%, $p<0.10$). Similarly, the risk of hypertension, arthritis, depression and ADL-disability is significantly higher for moderately obese women with

BMI of 32.5-35 vs. those with BMI of 30-32.5. The respective differences in health risks of moderately obese men are smaller and not significantly different. There are notable differences in the odds of poor self-reported health and ADL-disability among overweight women: those with BMI of 27.5-30 are 20% more likely to report ill health than slightly lighter women with BMI of 25-27.5 ($p<0.01$). The corresponding difference for ADL-disability is 34% ($p<0.01$).

The results on the effects of obesity on health are robust to the inclusion of physical activity measures in the model specification. Obesity is associated with significantly higher risks of poor health, disability and chronic health diseases independent of physical inactivity, although obesity-related differences in adverse health outcomes decrease slightly in models that include physical activity controls. For example, an increase in the probability of poor health between normal weight and obese men is 19 percentage points, which declines by 2 percentage points with adjustment for vigorous and moderate activity. The same 1-3 percentage point reduction in the estimates of obesity holds for other health outcomes (Appendix, Table A4). Hence, the association of obesity with poor health does not appear to largely reflect the effect of physical inactivity but rather has a health effect independent of engagement in physical activity.

Association Between Obesity and Health Care Outcomes

Mirroring its adverse impacts on health, obesity is associated with increased utilization of health care, although the gradient seems somewhat smaller than for health outcomes. From a perspective of outpatient services (Tables 4-5), moderate obesity is associated with a 20%-increase in the number of doctor visits for men and women as

compared to people of normal weight ($p<0.01$). Severe obesity is related to a higher differential in outpatient use among men (50%, $p<0.01$) than women (33%, $p<0.01$), although both effects are smaller than estimates from U.S. studies (Sturm et al. 2004, Andreyeva et al. 2004). Similar to the case of poor self-reported heath and ADL-disability, overweight is a significant risk factor for increased use of outpatient services only for women, yet the effect is relatively small (5%, $p<0.10$).

Estimates from a two-part model of the number of hospital nights suggest higher utilization of inpatient services by obese people. These effects are dominated by very high utilization rates among underweight, chiefly men, who are generally very sick in this age group. Severely obese men are predicted to spend in hospital on average one more night per year than men of normal weight (3.7 vs. 2.7 nights, $p<0.10$ in the 1st stage of the model), whereas the corresponding difference for moderately obese men is virtually zero. Overweight men are likely to spend even less time in hospital than their normal weight peers ($p<0.01$ in the 1st stage). In contrast to men, moderately obese women have significantly higher utilization of hospital services than the normal weight group (3.0 vs. 1.9 nights, $p<0.05$), which perhaps reflects low use of inpatient services among normal weight women as compared to men rather than higher use rates among obese women. Similar results on higher health care use associated with excessive body weight are found in models with gender-specific BMI categories (Tables 6-7).

Association between Obesity and Labor Force Participation

Obesity is related to all categories of labor force participation albeit the effects differ by gender and degree of obesity. In particular, overweight and obesity is associated with increased retirement in women, whereas retirement rates across weight groups are

almost identical for men (Tables 4-5). Severely obese women are 10% more likely to be retired than normal weight women ($p<0.01$). Employment rates are on average 30%-lower among severely obese women ($p<0.01$) and 20%-lower among severely obese men vs. normal weight ($p<0.01$). Similar magnitudes are suggested by results from models with gender-specific BMI groups (Tables 6-7).

Relative differences in disability rates across BMI groups are more substantial because the prevalence of work disability is low for all groups. For example, disability rates are almost double among severely obese men as compared to normal weight (97%, $p<0.01$) and even higher for women (140%, $p<0.01$). Less striking differences, albeit still statistically significant, emerge for disability rates between moderately obese and people of normal weight. Finally, obesity is associated with unemployment, particularly among severely obese men (6.7% vs. 4.6%, $p<0.01$). No clear patterns are apparent between obesity and homemakers among women.

I test sensitivity of the employment effects by BMI group to the inclusion of health controls in the model. Two types of health measures are explored: chronic health conditions like cancer, stroke and lung disease that correlate weakly with obesity but are likely to affect employment, and self-reported health, which is a significant correlate of excessive body weight and also a predictor of employment outcomes. The inclusion of the three chronic conditions has virtually no effect on the estimated differences in employment and retirement rates by BMI group: the effects related to obesity decline by less than 1 percentage point. The only notable change due to the model adjustment is the effect of severe obesity on work disability, which reduces by one forth. In contrast,

adding self-reported health decreases the estimated effects on labor supply outcomes at least by half, most likely underestimating the effect of obesity on the labor force status.

Cross-Country Variation in the Effects of Obesity on Health, Utilization of Medical Care and Labor Force Participation

Tests for interactions between BMI and country indicators reveal no significant cross-country variation in the health and employment effects of relative body weight. In other words, the slope of the obesity-health relationship is statistically equivalent across the SHARE countries. The same conclusion holds for health care utilization and labor supply associations with obesity. For all outcomes in most countries and regardless of what country is used as a baseline, the interacting terms of BMI with country dummies are neither individually nor jointly significantly different from zero. The analysis of interactions between BMI groups and country indicators depicts similar results.

Estimates from the analysis conducted individually in each country accord with conclusions for the overall sample (Appendix, Tables A5-A6). Excessive body weight is associated with poor self-reported health, ADL-disability and chronic health conditions, especially hypertension and diabetes, in virtually all countries examined individually. There are several exceptions. For example, obesity is not related to self-reported health among Greek men and to ADL-disability among men in Austria, Germany, the Netherlands and Spain. Some countries, particularly in Southern Europe, show no significant link between obesity and high blood cholesterol. The risks of obesity for arthritis are much less visible for men than women in most countries, which may reflect higher prevalence of arthritis among women (Murtagh and Hubert 2004). Heart disease is

another condition that varies in the effects of obesity across countries, yet without a clear pattern, perhaps suggesting that other risk factors play a more important role in determining the prevalence of heart disease in the country. Finally, depression is a condition whose relationship with obesity seems to vary primarily by gender but also by country. The evidence on significant risks of obesity for depression is apparent in most countries for women, yet only in a couple of countries for men (e.g. France). Differences in depression rates do not explain the observed gradient.

The analysis of health outpatient utilization suggests that obesity is related to higher use of health care services in most countries, particularly for women (who generally have higher rates of outpatient care use). There are exceptions; including countries with high and low obesity rates such as Spain, Switzerland, Denmark and the Netherlands for men, and Greece and Switzerland for women. The data on use of inpatient services is too limited to enable separate analyses of these outcomes by country.

I compare the obesity-health/labor supply gradient between countries with high obesity rates and countries with relatively low prevalence of obesity. The purpose of this analysis is to evaluate whether obesity has a differential effect on health and employment outcomes depending on the prevalence of obesity in the population. For example, if many individuals are obese in someone's reference group, people may perceive their weight differently than if they were in the group with few obese people. This could imply differential effects of obesity depending on the reference group, chiefly for outcomes like depression, employment and perhaps self-reported health. Health care systems may also address obesity and related health conditions somewhat differently depending on the distribution of obesity in the population. The group of countries with relatively high

obesity rates includes Austria, Germany, Spain, Italy and Greece for men and women; a comparative group is Sweden, Denmark, the Netherlands, Switzerland and France.

The data does not support the hypothesis of differential effects of obesity on health and employment depending on the prevalence of obesity in the population. The results are mixed and not revealing a systematic pattern in the effects of obesity between the two groups (Appendix, Table A7). For example, an increase in several major health risks related to obesity is higher for men in the "low-obesity" countries, but this is not true for women. Utilization patterns offer a different story from the health findings, suggesting that obese men use more medical resources in the "high-obesity" countries than in countries with low obesity rates. The results on the obesity-employment gradient differ by gender.

Comparison of the U.S. and Europe

Cross-country differences in obesity patterns within Europe are generally smaller than attendant intercontinental disparities. The prevalence, effects and distribution of obesity among the older U.S. population reveal several patterns that are notably different from analogous characteristics in Europe. First, the prevalence of obesity among American men and women ages 50 and older is about ¼ higher of the corresponding estimate in SHARE. For example, 21.7% of US adults aged 50+ were obese in 2000, based on self-reported weight and height (Zablotsky and Mack 2004), whereas the prevalence in SHARE 2004 is 16.2% for men and 17.8% for women. Only the Spanish population has higher obesity rates than those in the U.S., which is due to highly prevalent obesity among women in Spain. Gender differences in the weight distribution

of older men and women are similar between the two regions: men are more likely than women to be overweight and less likely to be obese.

Secondly, the obesity-health gradient in the U.S. differs somewhat from analogous estimates for Europe. Whereas the risks of moderate obesity for health are similar for U.S. men and women and their European peers (age 50-70), severe obesity generally implies a greater increase in health impairments in the U.S. than in Europe. For example, a rise in disability rates among severely obese vs. normal weight men is 4 percentage points higher in the U.S. than in Europe (Figure 2). Severely obese American women have a higher increase in utilization rates as compared to the normal weight group than European women. There are no differences in the obesity-health care utilization gradient between European and U.S. men.

Differences in the Effects of Obesity on Health, Health Care Outcomes and Labor Force Participation Across Sub-Populations

The analysis of the obesity relationship with health and employment outcomes across socio-demographic groups finds few differences from the results for the overall sample. Obesity is a significant risk factor for morbidity and increased use of health care in all sub-populations. Depression is one health condition for which the strength of the association with obesity among men depends on socio-demographic characteristics. Severely obese low educated men are more likely to be depressed than normal weight men with the same education level ($p<0.10$), whereas this effect is not found for highly educated men. The largest differences in the effects of obesity across socio-demographic groups appear in labor supply models. Employment and retirement rates among men with

income above the median are not related to overweight and obesity. At the same time, less wealthy men are more likely to be retired and not working if they are obese ($p<0.01$).

The obesity-health gradient does not vary systematically across SES groups in the pooled sample (Appendix, Table A8). An increase in disability rates related to obesity is particularly high among low educated men, whereas an attendant rise in rates of poor self-reported health is the highest among men with tertiary and women with secondary education. There are no consistent patterns in some SES groups being systematically affected stronger by obesity than other population groups. This finding accords with the observed lack of variation in the cross-country effects of obesity on health/ labor supply.

Other Explanatory Variables

The association of health risks with socio-demographic characteristics is similar to findings from earlier studies and the U.S. data (DHHS 2000). For example, higher odds of poor self-reported health are related to age, smoking, low education and income. In addition, married women are less likely to report their health as poor. The primary risk factors for most chronic health conditions are age and education (with the exception of high cholesterol levels in men). The effects of other socio-demographic and behavioral controls like income, marital status and smoking vary across health conditions from a small effect on the odds of arthritis to a significant role in the odds of depression. The effects differ by gender. Heart disease and hypertension in women are related only to age and education, whereas past smoking is an additional risk factor among men.

The use of outpatient services relates weakly to socio-demographic factors other than age and tertiary education. Smokers or people with greater incomes do not use more

ambulatory services than the rest of the population. Another significant correlate of lower utilization of outpatient services among women is their marital status (marriage), which accords with findings of better self-reported health among married women.

The socio-demographic correlates of labor force outcomes include age, education, and marital status. When both men and women have lower employment rates (and accordingly higher retirement rates) among less educated and older people, the effect of marital status is different by gender. Married men are more likely to be employed than their single peers, and the opposite is true of women. Finally, disability rates are higher among least educated, older, single men and women, and smokers among men.

Decomposition Analysis

Decomposing the obesity contribution to disease, I estimate that obesity explains on average about 10% of the prevalence of the health conditions examined. This suggests that in the obesity-free world the prevalence of disease could be lower approximately by a tenth of the current rates. Given that many conditions are not very prevalent, this would be a relatively small absolute change, yet it could affect many people given the population size. For example, disability among men would be lower by about 1% percentage point from the current 9%-rate if there were no obesity in the population. In general, the estimated contributions of obesity vary by country, gender and health condition (Table 8). The average effect is the largest for diabetes (17% for men and 24% for women) and lowest for depression (2% and 4%). Similar to the estimates of the association between obesity and health, obesity has on average a larger contribution to adverse health outcomes for women than men (due to both higher prevalence of obesity

and higher relative risks associated with obesity). For example, ADL-disability is 14% due to obesity among women and 10% among men, whereas for poor self-reported health the corresponding estimates are 9% and 6%. The obesity contribution to the prevalence of hypertension, arthritis and high cholesterol is similar for men and women.

I compare the contribution of obesity to ill health with the effects of other risk factors, such as current and past smoking, excessive alcohol drinking and aging. For key health outcomes like self-reported health and disability, the contribution of obesity to the prevalence of adverse health exceeds an attendant role of other risk factors, particularly for women. For example, past smoking or a decade of human aging explains 5% of poor health among men (vs. 6% for obesity). Smoking accounts for up to 2% of poor health and disability among women, whereas aging is responsible for 6% of poor health and about 10% of disability prevalence (Appendix, Table A9). The contribution of obesity is not highest for all health outcomes. Heart disease is one example where the effect of obesity is below the contributions of past smoking and aging in men and aging in women.

Finally, obesity appears to account for a small proportion of health disparities across countries. Had all countries the same prevalence of obesity, variation in health across nations would still remain substantial. For example, assuming an average effect of obesity on poor self-reported health in two countries with similar obesity rates (Germany and Greece), the 12-percentage point gap between rates of poor self-reported health among Greek and German men would reduce by 1 percentage point. Absolute changes for other countries and outcomes are often even smaller. Simulations of obesity prevalence across countries and the attendant effect on health give a similar message that

cross-country variation in obesity is unlikely to explain a notable proportion of health disparities across nations.

5. CONCLUDING REMARKS

In this paper I use nationally comparable data on Europeans aged 50 and above to explore the relationship between obesity, health, utilization of medical care and labor force participation at older age. I examine whether the gradient of obesity for health, medical care and employment outcomes is similar across countries or whether institutional, cultural and socio-demographic differences throughout Europe modify that relationship. I further investigate how differences in the prevalence of obesity across nations can explain the observed heterogeneity in health and compare the contribution of obesity to disease prevalence with the effects of risk factors like smoking and aging.

Based on nationally representative large samples, I provide estimates of the high prevalence of obesity and related chronic health conditions in older Europeans, particularly in Southern Europe. The differences in obesity rates across countries are substantial and cannot be explained by variation in socio-demographic characteristics of the populations. Based on self-reported weight and height, the prevalence of obesity among older Europeans varies from 13% to 25% across nations, exceeding in some countries high U.S. rates. Till now, such estimates were not available from other sources.

Similar to studies in the general population, this analysis suggests that obesity is strongly associated with major health risks for older adults. The odds of disability, poor self-reported health and chronic health conditions are multi-fold for obese men and women as compared to normal weight people, and hold independently of the effects of physical inactivity on health. Particularly high risks of disability and impaired health are

related to severe obesity in older people, especially women. The obesity-related health risks persist across all countries and socio-demographic groups and are not sensitive to changes in the model specifications. They are similar to estimates based on the U.S. data, although some differences emerge in the obesity-health gradient between the two regions.

Like earlier research, this analysis reveals considerable differences in health risks related to excessive body weight by degree of obesity. Severely obese women report poor/fair health almost twice as often as normal weight women, whereas the respective difference for moderately obese women is 50%. This accords with estimates from other studies on the differential effects of excessive body weight by severity of obesity (Field et al. 2001, Sturm et al. 2004). One research contribution of this analysis is to show significant variation in the health effects of human adiposity within standard BMI groups. For example, there are large differences in the odds of ill health and disability within the group of overweight women. Morbidity related to excessive body weight is reflected in increased utilization of outpatient health care services among the obese.

The link between obesity and labor force participation shown here has a perspective for research and relevance for policy. The association of obesity with reduced employment and higher disability rates is particularly strong among older severely obese men and women. Increased retirement rates related to obesity appear only for women. The association of obesity with labor supply outcomes is not independent of SES, with stronger effects for people of lower income status.

The study does not find strong evidence that institutional and cultural environment across countries modify the linkage between obesity, health and labor force participation. Cross-country differences in the slope of the relation between obesity,

health, medical care and labor supply outcomes are statistically insignificant. Further research based on larger datasets could be desirable to conclude whether such findings are due to lack of statistical power or reflect the actual effect of obesity that persists across countries and population groups. The comparative analysis of this paper, however, suggests that the impact of obesity is similar at least in such a relatively close geographic area as Continental Europe and in countries with the same institutional feature, as universal health care coverage.

I explore how the effects of obesity on health are related to institutional characteristics (e.g., generosity of health insurance, total health expenditure, physicians supply) and selected population features (e.g., obesity prevalence, smoking, food supply, life expectancy). No clear pattern is apparent between the obesity-health gradient and institutional and social indicators (Appendix, Table A10). For example, the effect of obesity on health may be both very high and relatively low in countries with generous health insurance systems (out-of-pocket expenditures in total health care costs). Countries with higher health care spending or greater physician availability do not necessarily have on average lower adverse effects of obesity on health. Behavioral patterns among the country population also do not seem to reflect trajectories in the obesity effects.

At the same time, institutions and cultural norms may account for the observed large heterogeneity across countries in the prevalence of obesity and related chronic health conditions. Obesity explains about one tenth of disease prevalence in the participating countries, exceeding the attendant contribution of other behavioral risk factors. Health disparities across European countries would still be large if all countries had the same obesity rates.

The analysis is essentially descriptive for the data analyzed is a cross-section of older adults that lacks the potential to identify and measure the clinical effect of excessive body weight on health. This data aspect precludes causal interpretation of the links between obesity, health and labor supply, which policymakers care about and which is generally required to initiate policy change. Establishing causal linkages is however not the purpose of the analysis. The available clinical and epidemiological evidence on the changes in health due to obesity, as well as the growing literature on the burden of external and internal costs related to obesity, should leave no doubt for policymakers at all levels about the importance of obesity for public health and the need for intervention. The observations from a cross-national analysis are however valuable for their unique capacity to help understand how country differences in institutions, culture, and socio-demographic characteristics explain the patterns in obesity and its consequences for health and employment. Furthermore, predictions of the outcomes related to obesity are feasible in a cross-section framework and important from a policy perspective.

Another limitation of this study is its reliance on the self-reported data of body weight, height and health conditions. Biases are known about individuals underreporting their weight (with an increasing extent among the obese) and overestimating height, particularly in older groups (Kuczmarski et al. 2001, Palta et al. 1982, Rowland 1990). The SHARE estimates based on subjective assessment of body weight and height are likely to underestimate the actual prevalence of obesity in the participating countries. If the tendency to systematically under- or over-report varies across countries, this could hamper cross-country comparisons. However, this hypothesis has been tested elsewhere with no evidence that correction for self-reported bias affects the obesity ranking of the

SHARE countries (Michaud et al. 2006). Secondly, undiagnosed chronic diseases could not be counted so that the effect of obesity in these cases would be underestimated. Cross-country differences in the definitions of disease, clinical criteria and access to health care suggest that the prevalence of specific health conditions based on self-reports of chronic ailments may be underestimated more in some countries than in others.

Nevertheless, the study provides new evidence that obesity has significant implications for increased morbidity of older adults, which are observed across all population groups and countries. Public and private health plans are recommended to consider the risks of excessive body weight for their beneficiaries that are likely to persist well into old age. The limited scope of earlier studies on obesity and labor force participation should not mislead policymakers that obesity has few implications for the labor market outcomes. This is certainly not the case for employment and work disability of severely obese men and women, whose number is already high in some countries and likely to be increasing. Whether for health or weight discrimination reasons, obese women are particularly likely to be affected and provide less labor. A message for public pension funds is that obese women have especially high rates of retirement. Longitudinal analyses need to investigate this hypothesis further. Differences in the effects of obesity on health and labor force status across varying groups of overweight and obesity should be considered to accurately predict the consequences of obesity at the individual and societal level. Whereas the data in this study does not allow estimation of the full spectrum of costs attributable to obesity, the results on health, utilization of medical services and labor supply suggest that the future financial burden of obesity in older cohorts is likely to be high.

CHAPTER 3 - Risk Factors for Obesity in Older Europeans

1. INTRODUCTION

This study analyzes risk factors for obesity among older population in Europe. An understanding of the causes of excessive body weight is needed to design programs that could help prevent the further spread in obesity, and attenuate the negative consequences of obesity for public welfare. The impact of obesity on morbidity and quality of life and its related high financial costs suggest that obesity-prevention programs should be high on the health policy agenda. Obesity is likely to be avoided through behavioral changes and lifestyle choices, which rational agents will undertake if the expected benefits exceed costs. The key factors contributing to the development of obesity are modifiable, and may be addressed through changes in incentives led by policy initiatives.

The analytic purpose of this paper is to ascertain factors related to obesity at the individual and country level, and evaluate the extent of their contributions to rates of obesity among Europeans aged 50 and above. The motivation for this research is multifaceted. Predictive factors of obesity need to be examined to identify who is most at risk for developing obesity. Whereas there is a substantial body of research on the role of genetic, behavioral, societal, and environmental factors and their interactions for the growth in obesity in the U.S., such data for other nations are more limited, particularly in specific population groups. The weight distributions are different between the U.S. and Europe, so the patterns of obesity established in the U.S. could diverge from those in Europe. Institutional variation across countries is also substantial, which may have different implications for the magnitudes of risk factors and the groups affected. It is also

unknown whether there is significant variation in the effects of risk factors associated with obesity across nations.

The prevalence of obesity is higher in the lower socio-economic strata (SES) in the U.S. among women and children, and less consistently among men. It needs to be established whether such patterns in the SES-obesity gradient are persistent in other developed countries, and if not, why. Public policy could modify the relationship between obesity and income through manipulating food prices or public health interventions. This research compares the SES-obesity gradient across European countries. We need to understand what population groups are at risk for obesity so that interventions target those in need more effectively.

In this paper I use comparable data from 10 European countries to ascertain risk factors for obesity in adults aged 50 and above. The research is designed to answer four questions: (1) What is the association of obesity with physical activity, socio-demographic characteristics, and food expenditure after the age of 50; and what are the magnitudes of the associated risks and most affected groups? (2) Is the gradient of obesity and its risk factors similar across countries? (3) What is the contribution of risk factors and their differential prevalence to the heterogeneity in obesity across nations? 4) What is the relation of historic trends in economic wellbeing, food consumption, and diet composition with current obesity rates?

I estimate multivariate regression models of the association between physical activity, socio-demographic characteristics, food expenditure and obesity using a pooled sample of all participating SHARE countries and individually by country. I fit logistic regression models for a dichotomous measure of obesity and consider a linear measure of

excess body weight in sensitivity analysis. I estimate pair-wise correlations between obesity and country-level variables that measure food availability, diet composition and food prices, as well as historic trends in food consumption and economic wellbeing.

Based on nationally representative large samples of older Europeans, I provide estimates of the strong positive association between lack of physical activity and obesity, particularly among women. The differences in obesity rates by physical activity status are substantial, and health differences cannot explain the gap in physical activity rates between obese and non-obese respondents. Like in other populations and studies, low SES is predictive of obesity in older Europeans. The SES effects come dominantly from low education, especially among men. The gradient of obesity with SES and physical activity does not vary systematically across the SHARE countries, so that institutional and cultural differences across European nations do not seem to modify the effects of risk factors on obesity in a systematic way.

In Europe obese people mainly eat at home. It is likely that the mechanism of food-related weight gain is different between many European populations and the U.S. Education appears to play a key role in explaining differences in obesity rates across the SHARE countries, yet behavioral factors like physical activity are important as well. These factors can be modified through changes in incentives and information. They are more responsive to policy initiatives than are more structural factors like education or income status.

The remainder of the paper includes further background and a discussion of the literature in Section 2, a review of the analytical strategy and estimation in Section 3, presentation of results in Section 4, and a summary of the analysis in Section 5.

2. BACKGROUND AND LITERATURE REVIEW

Obesity is a complex multi-factorial chronic disease developing from interactions of genetic, social, behavioral, and psychological factors. It is a consequence of a continuous energy imbalance that can lead to a gradual but persistent weight gain even when the daily energy surplus is minor. Once the obese state is established, physiological processes tend to defend a new weight (WHO 2000). Internal physiological processes primarily regulate body weight, but it is also influenced by external societal and environmental factors. The following review briefly summarizes research in both areas.

Individual and Biological Susceptibility

Some people are more susceptible than others to weight gain, so that obesity is not always a result of lack of adherence to recommended dietary and physical activity norms. The influence of genetic factors and identification of the genes responsible for the predisposition to obesity are difficult to establish, and the estimates of the obesity heritability vary. Family studies suggest that about 25% to 40% of the differences in body mass or fat may depend on genetic factors (Bouchard et al. 1998, Tambs et al. 1991). Studies on twins reared apart estimate the genetic contribution to body mass at about 70% (Stunkard et al. 1990, Allison et al. 1996a). In relative terms, the risk of obesity for first-degree relatives is about 2 for overweight, 3 to 4 for moderate obesity, and 5 or more for severe obesity (Allison et al. 1996b, Lee et al. 1997).

The influence of genetic factors is often modified by non-genetic factors. Interactions between genetic and environmental factors in the development of obesity are considered significant determinants of excessive weight gain and the recent growth in

obesity. Some individuals are more susceptible to the environmental influences promoting weight gain for medical, behavioral or genetic reasons. Identifying population groups with particular susceptibility to the environmental influences of obesity-promoting behavior is a key task on the obesity research and policy agenda. For example, migration studies have repeatedly shown that certain ethnic groups are more likely to develop obesity when exposed to an affluent lifestyle (Ravussin et al. 1994). The observed socio-demographic variation in obesity also cannot be attributable solely to the genetic factors. Body image concerns, culturally determined attitudes about food and physical activity, other relevant motivations vary across ethnic background, age, income, education, and occupation groups, which can modify the potential genetic influence. Finally, the rapid growth in obesity over the last 30 years could not be due to genetic factors because the genome changes within populations do not occur in a short period of time.

Dietary and Physical Activity Patterns

Dietary factors and physical activity patterns, which strongly influence the energy balance, are generally the consequences of individual choices. They are considered the major modifiable factors through which external factors promote weight gain. The rising proportion of fat and energy dense diets along with increasingly common sedentary lifestyles are thought to be major contributors to the growth in obesity worldwide (WHO 2000). In countries like the U.S. there is abundance of palatable, calorie-dense food, and the critical features of obesity-promoting diets are low energy cost and high palatability. A number of studies have repeatedly linked an increased dietary intake and changes in

the composition of diet to excess weight gain. Growth in the consumption of snacks (Zizza et al. 2001), caloric beverages (Harnack et al. 1999, Ludwig et al. 2001), and fast foods (French et al. 2001) among children and younger adults; increased consumption of dietary sugars and fats (Harnack et al. 1999); larger portion sizes (Young and Nestle 2002), and the lower nutrient density of foods eaten away from home (McCrory et al. 1999, Lin et al. 1999) have been associated with the rise in obesity due to dietary factors. Researchers also hypothesize whether early deprivation leads to a higher propensity for overweight and its comorbidities (NIH 1998). Furthermore, the effect of breastfeeding on the risk of overweight in later life is under investigation in the research community with some studies suggesting a protective effect (Harder et al. 2005) and others disputing this conclusion (Burgette et al. 2006).

Food-related changes present only one side of the energy balance equation. With low levels of physical activity even a calorie intake within the recommended levels may lead to accumulating excess energy and weight over time. The effect of physical activity on weight gain and loss has been documented extensively, including the causal pathways. Evidence from randomized control trials shows that physical activity or aerobic exercise in overweight and obese adults leads to modest weight loss independent of the effect of caloric reduction through diet (NIH 1998). There are spillovers from combining a reduced calorie diet and increased physical activity in terms of greater weight loss than with diet or physical activity alone (Garrow et al. 1995). Cross-sectional studies generally establish an inverse relationship between physical activity and body weight (Miller et al. 1990, Tremblay et al. 1990). Longitudinal studies with 2 to 10 years of follow up find that physical activity is related to lower weight gain over time (Ewbank et al. 1995,

Klesges et al. 1992), and smaller gains in weight after smoking cessation in women (Kawachi et al. 1996). Most evidence on the weight effects of physical activity suggests that physical activity may play a role in long-term weight control and maintenance of weight loss.

Environmental and Societal Influences

A strand of the obesity development literature considers the environmental and societal factors that are affecting a large proportion of the world population. These powerful forces altered the cost of dietary and leisure time choices and moved individual behavior towards the lifestyles promoting obesity. Technological growth has increased incentives to be overweight, and the technological change theory suggests that at least some of the growth in obesity has been a matter of rational individual choice.

Economic Analysis of Obesity

One principal hypothesis of economic analysis into the determinants of obesity is that obesity growth is the result of economic forces that changed relative prices of the lifestyle choices. Technological progress is thought to be accountable for many changes in the cost of time and economic resources. Lakdawalla and Philipson (2002) attribute trends in adult obesity to technological change that reduced real food prices through agricultural innovation and shifted away the work environment from manual labor to sedentary activities. Technological growth had induced excess weight gain by raising the price of burning calories for about 40% due to lower food prices and 60% due to reduced physical activity in home and market production (Lakdawalla and Philipson 2002).

One consequence of technological advances is a reduction in the time cost of preparing meals at home. Technological innovations made it possible to produce more appetizing food far from the point of consumption and consume it at a lower time price. Cutler et al. (2003) attributed the growth in obesity within the U.S. to technological changes of mass production and, as a result, individuals consuming more calories in a greater number of meals (chiefly snacks) rather than more calories per meal. Population groups that have had the most ability to take advantage of technological changes, such as married women, had the biggest increases in weight. Married women used to stay at home and eat primarily home-cooked food, but after joining the labor force they have increasingly shifted to consumption of precooked market food and outside home food.

One important economic change over the past decades has been an increase in the value of time, particularly among women, which is apparent from higher employment rates and hours of work. Growth in relative income among certain population groups has also increased working hours. The rise in market time, which left less time for home and leisure activities, has been associated with increased demand for convenience food and consumption outside home, particularly in fast food restaurants. Fast food and convenience food are inexpensive, and have a high caloric density (calories per pound) to make them palatable (Schlosser 2001). Total calorie intake is known to rise with caloric density if the reduction in the amount of food does not offset the increased density (Mela and Rogers 1998). The likely effect on obesity from new food patterns is straightforward, as evidenced by studies on the dietary factors and weight gain.

The increasing availability of fast food, which reduces search and travel costs, led to structural changes in the relative cost of food prepared at home, meals consumed in

fast food and full-service restaurants. Chou et al. (2004) considered how trends in obesity in the U.S. are related to state level measures including the per capita number of fast-food and full-service restaurants, the prices of meals, food consumed at home, cigarettes, and alcohol, and clean indoor air laws. Researchers find large positive effects associated with the per capita number of restaurants and obesity, and attribute it to the rising scarcity and value of household time.

Smoking and Obesity

Another important societal change in the U.S. is the increased real cost of cigarette smoking. This is a consequence of both direct effects of higher tobacco prices and indirect costs related to legislative restrictions on smoking in public places and the workplace, and diffusion of information about the serious adverse health consequences of smoking. As a result, smoking rates have fallen in the U.S., whereas smoking tends to affect weight. Individuals who quit smoking are likely to gain weight (Pinkowish 1999). One literature review found that from 58% to 87% of those who quit smoking gained weight (U.S. Department of Health and Human Services 1990). Many smokers, especially women, do not attempt to quit due to fears of weight gain (Caan et al. 1996).

The effect of reduced smoking on weight gain and the growth in obesity has had mixed evidence in research to date. Some studies find the positive association between higher cigarette prices, which reduced smoking, and increased rates of obesity as unintended consequences of the anti-smoking campaign (Chou et al. 2004, Rashad and Grossman 2004). Researchers conclude that the growth in obesity is the price that society has paid to achieve socially desirable goals like expanded labor opportunities for women

and less smoking. At the same time, Gruber et al (2006) find no evidence that reduced smoking leads in a major way to weight gain and rising obesity rates in the U.S.

Knowledge and Obesity

In the environment promoting weight gain, individual attitudes and preferences are critical in weight control. Many people live in daily routines that are sedentary at work, home and commute. Aggressive food marketing and large food portions served outside home promote high calorie consumption. Some socio-cultural traditions further induce overeating and consumption of high fat/energy dense food. Under the influence of such external factors, knowledge about obesity causes and risks, as well as motivation and self-control skills are required of people who are genetically prone to overweight. Rational individuals who are aware of the consequences of obesity for health should have higher perceived or expected costs associated with obesity. Knowledge about obesity health risks may help prevent an individual from becoming overweight (Kan and Tsai 2004). Whereas addictive substance consumption (e.g., smoking) in response to perceived health risks is well researched, the relationship between lifestyle choices and obesity-related knowledge is yet to be explored.

SES Profile of Obesity

The public health literature showed a significant link between socio-demographic characteristics and obesity in the U.S. and other countries. Although there are differences by gender, obesity rates are generally higher among low SES groups (Chang et al. 2005, NIH 1998, Paeratakul et al. 2002, Wardle et al. 2002). The cost consideration of the

lifestyle choices like diet is one important factor in explaining the SES differences in individual behavior and body weight. Healthier diets cost more than diets high in fats and sugar (Drewnowski et al. 2004). Nutrition professionals showed that lower SES groups are likely to consume cheap concentrated energy from fat, sugar, cereals, potatoes and meat products but very little intake of vegetables, fruit and whole grains (Quan et al. 2000, Reicks et al. 1994). Shifting taste and food preferences in the direction of less energy-dense food is importantly a question of cost.

This study contributes to the literature along several dimensions. First, I provide data on risk factors for obesity in older adults from 10 European countries. The aim of this analysis is to investigate whether the obesity-related patterns observed in the U.S. hold in other populations as well. Second, I compare the effects of risk factors for obesity across countries to determine whether institutional, social and economic differences modify the gradients. Third, I estimate the contributions of risk factors to the variation in obesity rates across nations. Finally, I explore how historic trends in food consumption, diet composition, and economic wellbeing are related to current obesity rates.

3. DATA AND METHODS

The data source and sampling are analogous to the SHARE data used in the study on the effects of obesity on health, utilization of medical care and labor force participation. The survey design and sample are discussed in Chapter 1.

In addition to SHARE, this study also uses a battery of macro-level statistics from multiple international sources like the Food and Agriculture Organization (FAO) of the United Nations, OECD, the Statistical Office of the European Commission (Eurostat),

and economic history data from the OECD (Maddison 2000). In particular, I rely on food commodity data from the FAO Food Balance Sheets, which provide cross-country estimates of per capita daily food consumption, sources of dietary energy, average daily fat/protein consumption and other food commodity statistics collected since 1961 (FAO 2006). The FAO food consumption refers to the amount of food available for human consumption in the country as estimated by the FAO Food Balance Sheets. The actual food intake may be considerably lower of that estimate because food availability depends on the magnitude of food wastage and losses during transportation, storage, and cooking. The extent of such attrition is estimated on average at 25-30% (FAO), but it may vary across countries and over time. Pet food consumption and food given away or consumed by non-residents (e.g., tourists) is also part of the FAO food data, and thereby further overestimates the actual amount of calories consumed per capita in the nation. Throughout the paper, I will refer to the FAO data as food availability to highlight the difference in the food supplied for human consumption and the actual food intake. The latter would be a key indicator in the study of risk factors for obesity, yet collection of such data is limited to food recall diaries and unavailable for a large-scale cross-country study of my type.

OECD and Eurostat provide macroeconomic statistics like GDP, food price indices, national expenditure on health and its funding sources. The OECD Health data give estimates of the prevalence of behavioral risk factors, such as smoking in adult population. Maddison's book is a source of historic data on trends in the global economy during the last century. It includes estimates of GDP, population, productivity, and GDP per capita for the period of 1820 to 1992.

Outcomes

The single outcome in this analysis is obesity defined as a respondent's body-mass index (BMI) of 30 and above. Although obesity is a matter of excess adipose tissue, it is costly to measure the exact amount of fat, and such an evaluation method is not practical in large-scale household surveys. Most social science research therefore relies on BMI to define obesity based on either self-reported body weight and height (as in this study) or objectively measured estimates. The BMI approach to obesity measurement has a number of disadvantages (discussed in the previous paper), but at the same time it is convenient for data collection and reasonably valid. BMI has been shown to correlate highly with the fat tissue measurements in medical settings (Revicki and Israel 1986).

I compare the estimates of obesity prevalence among older adults in SHARE with attendant statistics for adult population (age 15+) from other sources like the WHO and the International Obesity TaskForce (IOTF). The data seem to accord well between the sources, particularly for men. The correlation between average BMI in SHARE and estimates from the national surveys presented in the WHO Global InfoBase is 0.68 ($p<0.05$) for men and 0.43 for women. The correlation for the prevalence of obesity is 0.63 ($p<0.05$) for men and 0.52 for women in WHO-SHARE comparisons, and correspondingly 0.61 ($p<0.05$) and 0.59 for the IOTF-SHARE. Perhaps reflecting strong cohort effects, obesity rates among older population are substantially higher than the prevalence in the general population in some countries, e.g. Spain (23% vs.15%). Still, the top five countries with high obesity rates in SHARE and the WHO are the same countries for men and four out of five for women (results not presented).

Explanatory Variables: Micro-Level Analysis

Physical Activity: The vector of physical activity measures includes assessment of participation in vigorous and moderate physical activity and the frequency of participation. The survey collection of data on physical activity largely determines the extent to which this analysis can evaluate the intensity and type of physical activity among respondents. The level of engagement in exercise or vigorous physical activity in one's daily life is evaluated from responses to the survey question "How often do you engage in vigorous physical activity, such as sports, heavy housework, or a job that involves physical labor?" Participation levels for moderate physical activity are assessed in another question: "How often do you engage in activities that require a low or moderate level of energy, such as gardening, cleaning the car, or doing a walk?" Both questions allow respondents to reply on a 4-point scale: 1) More than once a week, 2) Once a week, 3) One to three times a month, and 4) Hardly ever, or never.

I combine the medium responses in one group "Once a week/1-3 times a month" for two reasons. First, the preliminary analysis revealed little difference in terms of obesity and health between the two categories. Secondly, there are relatively few observations in each group, and the sample size could be an issue otherwise. I construct a 3-point scale measure of vigorous and moderate physical activity, and evaluate the two measures independently and jointly. I also experiment with measures of vigorous and moderate physical activity that indicate "yes/no" involvement in the corresponding activity more than once a week. These measures could be the best possible approximation of the physical activity levels according to recommendations for adult population by the U.S. government, which advocate engagement in vigorous physical activities at least 3

times a week for no less than 20 minutes and at least 30 minutes in moderate-intensity physical activity on 5 or more days a week (CDC 2006).

Table 9 presents data on vigorous and moderate physical activity in SHARE. There is high correlation between responses across types of physical activity. For example, very few individuals report lack of moderate physical activity among those who often engage in vigorous physical activity. Similarly, people not reporting regular moderate activities are unlikely to engage in vigorous activity too. On average 9% of men and 15% of women reveal lack of any vigorous or moderate activity. The levels of physical inactivity among obese are almost the same as average for men (10%), but much higher for women (21%, $p<0.01$). On a weekly or more frequent basis, 26% of men and 31% of women do not engage in vigorous or moderate physical activity. These estimates cannot be directly compared to the U.S. data due to differences in the survey questions. For example, 23% of SHARE 65-year olds report participation in vigorous physical activity more than once a week, whereas the median percentage of the same age Americans reporting 20+ minutes of vigorous physical activity on 3 or more days per week is 14% (BRFSS 2005). There is substantial variation in rates of physical activity within SHARE (Appendix, Table A11). Lack of physical activity is the least prevalent in the Nordic countries (5-6% among men and 8-10% among women), whereas Southern European countries, except Greece, have high rates of physical inactivity (10-16% among men and 15-25% among women).

Food Expenditure: The purpose of food expenditure measures is to approximate food consumption, which is not available in another way from the individual-level data. The survey asks about household spending on food to be consumed at home and outside

home in a typical month during the year prior to the interview. Household expenditure on all goods and services are evaluated as well. The expenditure data is collected in a local currency in countries from a non-Euro zone (e.g., Switzerland) and then transformed in Euros. I use food price level indices trying to reduce cross-country differences in food expenditure that are due to differential food prices. The price level indices, calculated as the ratio between Purchasing Power Parities (PPPs) and exchange rates for each country in relation to the EU average, provide a comparison of the countries prices with respect to the EU average in 2003 (Eurostat 2004). For example, the food price index in Spain is 84 vs. the EU25 of 100 and 158 in Switzerland. The overall CPI is used to adjust household expenditure to a comparable scale. Price adjustments would not be necessary in within-country analyses, yet it may improve comparisons in estimations on the pooled sample.

I experiment with several measures of food expenditure. These include both the amount spent on food (on a logarithmic scale to account for outliers), and the food share in household monthly income (or household consumption of all goods and services in sensitivity analyses). I also conduct analyses by type of food expenditure evaluating the amount and share of expenditure on food consumed at home and outside home. Finally, I group households by the share of food expenditure relative to their income (<5%, 5-10%, 10-20%, 20-30%, 30-50%, 50% and above).

The data on food expenditure has a number of problems that limit their analysis. First, the number of missing observations or those with a zero value is very high (about 18% of the analytic sample). There are also cases when the reported food expenditure exceeds gross household income (4.5% of the sample). I exclude these data from the analysis of the food expenditure data, as cases with income lower than food expenditure

are likely to indicate a measurement error. To estimate the relative role of food expenditure for consumers, I used income instead of total expenditures because many households do not report total spending on goods and services (28% of the sample) or their estimates seem inadequate compared to food expenditure (e.g., the share of food expenditure in all household spending exceeds 85% for about half of respondents).

Table 10 shows the percentage of food expenditure relative to income by obesity status among the SHARE respondents.

SES Characteristics: The SES gradient is a vector of education and income measures. I assess education by the highest education attained (tertiary, secondary education; primary or no education is a reference). Household income is evaluated both on a categorical (four income quartile groups) and continuous scale as an inverse of a hyperbolic sine of annual pre-tax household income (Beyer 1987, Zwillinger 1995).

Explanatory Variables: Macro-Level Analysis

Food Availability: I investigate how obesity rates are related to the total amount of food available for human consumption in the country (daily energy in kcal per capita) and dietary components, including per capita protein and fat consumption, food energy by group of products (e.g., animal fats, vegetables, sugar), and the source of energy (carbohydrates, proteins, fats). All measures are evaluated at the country level. I also explore trends in food availability and diet composition over the period of 1961-2004, for which the FAO data have been collected. The analysis also includes prices of food and specific food products as potential correlates of obesity.

Historic Trends: The key measures to evaluate whether general economic conditions in the country in pre-natal and childhood years of respondents could be related to obesity rates in older age include GDP per capita over 1913 to 1950. This is approximately the period when the SHARE respondents were born and raised.

Analytic Procedure

I conduct estimations on the pooled data and individually by country using the same sample as in Chapter 1, except for the analysis of food expenditure data. That part of estimation is limited to the sample of respondents with complete non-zero food expenditure responses. I use individual sample weights to obtain nationally representative estimates of sample statistics but not in regression analysis. The Huber/White nonparametric correction gives robust standard errors. The models of food expenditure data, evaluated at the household level, adjust standard errors for clustering by household. I use logistic regression to generate the odds ratio for factors attributable to obesity.

All models evaluate how obesity is related to factors like physical activity, SES and/or food expenditure controlling for other socio-demographic and behavioral characteristics, such as age, current and past smoking, marital status. In addition to the observable individual characteristics, I include country fixed effects in all models estimated on the pooled sample. They represent cultural, economic and social factors that affect obesity similarly across individuals within countries.

I test for differential effects of physical activity and SES on obesity across nations. Cross-country variation in the gradient of obesity and physical activity might reflect differences in the intensity of aggregated physical activity levels in the countries.

For example, respondents reporting participation in vigorous activity more than once a week could do so on average 4 times/week in one country and half of that level in another country, whereas SHARE would assign them the same level of physical activity of "More than once a week". The implications for obesity may be more pronounced in the country with higher levels of activity. I test the hypothesis of differential effects of physical activity on obesity across countries by including interactions between country indicators and vigorous/moderate physical activity measures on a 3-point scale, as well as indicators for more than weekly participation in physical activity.

A similar exercise is conducted to test whether the SES-obesity gradient differs across countries. The hypothesis of such variation is based on the assumption that economic and social characteristics across nations may modify the relationship between SES and obesity by changing incentives for obesity in a systematic way. For example, government subsidies to agricultural producers could increase market supply and lower prices of specific product groups. This would affect the composition of the consumption basket, particularly in economically disadvantaged population groups that are more sensitive to relative price and income changes. I test the hypothesis of the differential SES-obesity gradient across countries by estimating joint and separate models with interactions between education and/or income quartile groups and country dummies.

As a sensitivity check, I analyze how the estimates of physical activity change when I correct the measurement of vigorous physical activity for occupational labor. In particular, I exclude people who report having a physically demanding job (N=3281, approximately a half of those in the labor force). Because the survey asks respondents to consider physical labor at a job when evaluating their vigorous physical activity, such

exclusion may provide a more accurate measure of exercise or leisure-time physical activity. The literature however seems to offer no evidence on whether occupational and leisure-time physical activities of similar intensity have different implications for obesity.

The study of macro-level variables is based on correlation rather than regression analysis. The number of countries is too small to enable meaningful estimations of multivariate regression models. Finally, I evaluate contributions of the analyzed risk factors into the prevalence of obesity using the decomposition technique developed in Kapteyn et al. 2004 and introduced in Chapter 1. I compare the role of physical inactivity, smoking, and SES in explaining differential obesity rates across countries.

Structurally, I estimate the following model in the paper. Consider an individual *n* in a country *c* and define the quantities with all notations other than o_{cn} as vectors: obesity (o_{cn}), physical activity indicators (w_{cn}), food expenditure in the food models (f_{cn}), SES (y_{cn}), socio-demographic and risk behavioral characteristics (z_{cn}), error terms (satisfying classical assumptions, distributed multivariate-normally) ε^{o}_{cn}, and parameters: $\alpha, \delta, \beta, \theta, \psi$. All parameters are fixed across countries in the pooled sample. With this notation consider the general model:

$$o_{cn} = \alpha + \beta w_{cn} + \delta\ f_{cn} + \theta\ y_{cn} + \psi\ z_{cn} + u_c + \varepsilon^{o}_{cn} \qquad (1)$$

The equation explains obesity as a function of incentives for weight gain-related behavior reflected in physical activity and food expenditure, observable and unobservable individual characteristics, social and economic policy, and an error term.

4. RESULTS

I review the study results presenting descriptive and adjusted estimates by risk factor for obesity. The findings for the overall sample are extended by an overview of cross-country differences in the pathways to obesity, including comparisons to the U.S. Decompositions of the behavioral and social contributions to obesity conclude this section.

Physical Activity

The analysis supports the hypothesis that lack of physical activity is strongly related to excessive body weight. Rates of obesity are systematically higher among individuals who are not physically active, particularly in women. If about 15% are obese among women reporting engagement in vigorous and/or moderate physical activity, it is 25% among the most inactive women (Table 11). There are gender differences in what type of physical activity is a primary correlate of obesity. I observe significant differences in obesity rates for men for vigorous physical activity but not for moderate physical activity (independently of the other type of activity). At the same time, both types of regular physical activity are associated with lower obesity rates among women. Another observation is that the prevalence of obesity is fairly similar across respondents engaging in physical activity at least once a month: weekly exercise, several times a month, and more frequent physical activity do not reveal systematic differences in terms of obesity. All results are robust to the exclusion of the respondents who have a physically demanding job.

Table 12 provides predicted rates of obesity from multivariate regression analysis. Similar to descriptive results, lack of physical activity is a significant predictor of obesity. Compared to the most physically active group (more than weekly participation in moderate and vigorous physical activity), women from the least active group (no regular physical activity of any type) are twice as likely to be obese (14% vs. 28%, $p<0.01$). The respective difference for men is 50% (14% vs. 21%, $p<0.01$). Lack of activities that require a moderate level of energy, independently of participation in vigorous physical activity, has a particularly strong negative effect on the probability of excessive body weight in women. In contrast to men, a decrease in the level of moderate physical activity is related to increasing obesity rates irrespective of reported levels of vigorous physical activity. Women who do not participate in vigorous activity move from 17% to 27% prevalence of obesity between the highest and lowest levels of moderate physical activity.

Country-specific estimations suggest similar results with a few exceptions. Lack of physical inactivity is predictive of obesity in all countries for women and in most countries for men. I find a weak association between physical inactivity and obesity among men in Southern European countries, except Greece. These are the countries with the highest rates of physical inactivity in the sample (Appendix, Table A11).

I explore the hypothesis that obese individuals do not engage in physical activity because they are in poor health. Morbidity implications of obesity are substantial, as discussed in Chapter 1, yet they are perhaps not the only source of the large variation in physical activity by obesity. Other observed and unobserved characteristics including modifiable factors can influence incentives of the obese to exercise. Communities that are

'unfriendly' to an active lifestyle, poor motivation/self-control, weight discrimination, low self-esteem and body image are several examples. Stratifying by self-reported health, I find that obesity-related differences in vigorous physical activity are very small among people in poor health. They reach at most half of the attendant differences among respondents in good health. In contrast, differences in terms of moderate physical activity by obesity status are bigger in the group of individuals in poor health, particularly among women. Non-obese participants reporting poor health are more likely than the obese in poor health to engage in moderate physical activity, such as walking, which presumably has relatively few significant health constraints. The findings suggest that health plays a considerable role in why obese individuals get much less exercise than the non-obese, but it probably does not account for all of the observed variation. When health is not an issue (at least reported), the obese still have lower rates of physical activity. I confirm this result in estimations that include poor self-reported health as a control variable and reveal a strong positive association between lack of physical activity and obesity (results not shown).

Food Expenditure

Food expenditure relative to income is significantly higher among obese respondents (26% vs. 23%, $p<0.01$), and the result holds within income groups. For example, among individuals in the lowest income quartile the obese have a significantly higher share of food expenditure relative to income than non-obese, particularly among men (38% vs. 42%, $p=0.07$). A minor share of household income (less than 10%) is on average spent on food by 24% of non-obese and 18% of obese individuals. At the same

time, more than 50% of household income is spent on food by 12% among the obese yet 8% in the non-obese group. In absolute terms, obese spend less on food consumed at home or outside home than non-obese respondents but the difference is statistically null. Eating out is less common among the obese than non-obese in many European countries, which is likely to differ from the U.S. patterns (Appendix, Table A12). Spending on food consumed outside home is reported at 10-15 percentage points lower rates by obese vs. non-obese respondents in Germany and Southern European countries (where obesity prevalence is high), whereas other countries have similar rates for outside home food consumption by obesity. Most obese respondents eat predominantly at home and spend on food consumed at home. This observation holds within income groups (i.e., obese individuals are significantly less likely to eat out than non-obese respondents within the same income category).

I do not find strong evidence that household food expenditure is related to obesity in the multivariate regression framework. The majority of the food spending measures does not demonstrate a statistically significant effect in either pooled estimations or analyses on population groups and countries (e.g., log of the total amount of food expenditure, groups by food spending relative to income). The effects that turn out to be significant are not robust across specifications or sub-samples. For example, the share of food expenditure in household income is positively associated with obesity for men but not women, and holds in the sub-sample analysis only for low-educated men. One consistent finding is that women with higher expenditure on food consumed outside home are less likely to be obese. The opposite effect is found for expenditure on food consumed home, which appears to affect only low-SES women.

Income and Education

Similar to earlier studies and data for the U.S., obesity in SHARE reveals a strong SES component. People of lower SES are more likely to be obese, and this relationship is robust across countries and gender. Table 13 presents differences in obesity rates between men and women from the tails of income and education distribution. All estimates (except for education among Greek women and income among men in Sweden) are positive and most of them are significant, suggesting that obesity rates are on average higher among people with lower education and/or income. The gradient is generally stronger for education among men, whereas income is more important among women in some countries and education in others.

Regression analysis indicates similar patterns in the obesity-SES gradient (Table 14). Men and women with secondary and tertiary education are less likely to be obese, and the result is fairly consistent across model specifications and countries. For example, the model predicts obesity rates among low educated men and women that are approximately twice higher the prevalence of obesity among people with tertiary education (20% vs. 10% for men and 12% for women, $p<0.01$). The respective difference compared to people with secondary education is ¼ (20% vs. 16%, $p<0.01$). Education is not a significant predictor of obesity only in the Swiss sample (the smallest in SHARE), as well as among men in France and women in Greece.

Differences in the predicted obesity rates by income are smaller than the attendant estimates for education groups. In particular, rates of obesity among men in the lowest income quartile are 3 percentage points higher than in the highest income group (18% vs. 15%, $p<0.05$), whereas the increase for women is 6 percentage points (21% vs. 15%,

$p<0.01$). In contrast to the pooled estimation and results for education in by-country analysis, income does not appear to be strongly related to obesity in a number of countries. Except for France and Germany, income shows no systematic patterns with respect to obesity in men. The same two countries and Sweden have a significant obesity-income gradient for women.

Obesity-SES Patterns in U.S. and Europe

There are notable differences in the weight distribution by income between the U.S. and European countries. Although obesity is associated with low SES in all countries, the gap between obesity rates in the tails of income distribution in the U.S. is particularly large. Based on the SHARE and U.S. HRS data for individuals born in 1931-1950, almost 3 out of 10 Americans in the lowest income quartile are obese, which exceeds obesity rates in low-income strata in all SHARE countries. At the same time, almost every fifth person is obese in the U.S. top income quartile. Some European countries have significant differences in obesity rates across income groups (e.g., France, Germany), but none of them observe as heavy clustering of obesity as there is among the American poor. Another distinction between European and U.S. obesity-income patterns is that countries with high obesity rates in Europe (Spain, Greece, Austria) are characterized by a relatively flat income gradient, whereas the U.S. has a steep income gradient similar to European countries with low rates of obesity (Nordic countries).

The average estimates of obesity prevalence among low SES Americans obscure key differences in the obesity-SES gradient by gender in the U.S. Whereas there is a steep rise in obesity rates with lower income among women aged 50-70, virtually no

income-related difference exists in the prevalence of obesity among U.S. men of the same age. This accords with results from earlier U.S. studies that find a weak link between income and obesity among men (Paeratakul et al. 2002, Wardle et al. 2002). Obesity is twice more prevalent among the poorest American women than women from the highest income quartile (32% vs. 15%, $p<0.01$); it varies between 20% and 24% among men from different income strata.

Age, Smoking and Alcohol Consumption

Age is related to obesity in a non-linear way. Most adults reach their maximum weight in late middle age (50-60), and may start losing weight, as they get older and experience decline in health. In the SHARE sample of adults ages 50 and above I observe the highest obesity rates among 65-70 year-old men (the years immediately following retirement for many respondents), which fall with age afterwards. Obesity rates among women are peak in the age groups of 55-60 and 70-75 year-olds, and start declining in mid-70s.

The association of smoking and obesity among older Europeans has similar characteristics to those observed in other studies and populations. Obesity rates are significantly lower among current smokers, particularly women. The model predicts that obesity rates are 2.8 percentage points lower among male current smokers than among men who never smoked ($p<0.01$). The attendant difference for females is almost double (5.4 percentage points, $p<0.01$). Smoking in the past is associated with higher current obesity rates only in men (3.3 percentage points, $p<0.01$).

Descriptively men who report drinking more than 2 glasses of alcohol almost daily or 5-6 days a week (which is in excess of recommended norms, CDC 2006) have similar rates of obesity as those with less drinking. The effect of excessive alcohol consumption is predictive of obesity rates among men in regression analysis, but the attributed effect is fairly small (2 percentage points, $p<0.05$). The role of excessive alcohol consumption in obesity is however large for women. Descriptive and adjusted rates of obesity are notably lower among women reporting alcohol consumption in excess of recommended norms (6 percentage points, $p<0.01$). Income-stratification analysis suggests the same results for the alcohol consumption-obesity gradient by gender.

Obesity Gradient with Physical Activity and SES across Countries

I find no significant cross-country variation in the relationship between physical activity and obesity. The result is generally robust across measures and types of physical activity, population groups, and model specifications (e.g., exclusion of occupational physical activity, use of continuous BMI as an outcome). Virtually all tests for individual and joint significance of the interacting terms between physical activity and country indicators reject the hypothesis that these terms are significantly different from zero. Hence, the slope of the obesity relationship with physical activity is analogous across the SHARE countries.

In a similar fashion, small cross-country differences are revealed for the SES-obesity gradient. In a variety of model specifications for both gender groups I cannot find any evidence that country characteristics change the association between SES and obesity in a systematic way. Even though descriptive statistics suggest that some socio-economic

groups are more likely to have higher obesity rates in one country vs. another (e.g., Table 13, income-related differences in obesity in France vs. Spain), I do not identify such differences in a multivariate regression framework.

Country-Level Correlates of Obesity

Table 15 presents coefficients from pair-wise correlations between obesity and country-level variables that measure food availability, diet composition, food prices, and historic trends in food consumption and economic growth. I conduct correlation analysis separately for obesity rates among men, women, and the overall sample. All obesity correlates are assessed at the country-level and are identical for men and women.

I find a significant negative association between food prices and obesity rates, so that countries with relatively low food prices compared to the European average are more likely to have higher obesity rates in the population. At the same time, the amount of food available for daily human consumption in the country is not related significantly to obesity (the correlation coefficient of 0.33 for all sample; 0.39 for men and 0.27 for women). The same relatively weak correlation is observed between average daily protein consumption and fat consumption (0.44 and 0.32 respectively). I also find no strong patterns in how obesity rates are related to the sources of dietary energy (carbohydrates, protein, fat), and consumption of particular food products. This may reflect a relatively similar structure of the food sources across European countries (e.g., the average share of fat calories in total calorie intake varies from 45% to 51%, protein from 11% to 13%)

In contrast, food availability several decades ago is related positively to current rates of obesity in the population. For example, a lower amount of food available for

consumption in the early 1960s is a significant predictor of today's high obesity rates (-0.67 in all sample, -0.55 for men and –0.72 for women, $p<0.05$). The strength of the negative association between food availability in the past and obesity rates in 2004 declines over time till the early 1990s when it becomes positive. In a similar fashion, rates of growth in food availability in European countries predict the prevalence of obesity today (0.79 in the 1970s and 0.68 in1980s, $p<0.05$; 0.79 for the period of 1961-2001). Compared to the rest of SHARE, Greece and the U.S. started at the bottom of per capita daily food consumption in 1961, but grew fast so that the U.S. led the ranking in 2000, and Greece moved from the 2nd at the bottom in 1961 to the 2nd top in 1990 (Appendix, Table A13). Both countries have high obesity rates; and, whereas the trend data are not available for Greece, the prevalence of obesity is known to have more than doubled since the 1960s in the U.S. (Flegal et al. 2002). The other three European countries with high obesity rates (Spain, Austria and Germany) did not have notable changes in food consumption that would affect their ranking by food availability.

The data on historic trends in the general economy and current obesity rates indicates higher prevalence of obesity in the countries with lower GDP per capita over the entire period (the correlation coefficient is –0.8, $p<0.05$). This observation is in line with evidence from micro-data on higher obesity rates among the poor. The analysis of GDP growth data reveals that countries with higher prevalence of obesity had slower than average economic growth over the period of 1913-1950, when most SHARE respondents were born and raised (Appendix, Table A14). Rather wealthy countries today, as well as in the beginning of the 20th century, Germany and Austria had on average poor economic growth over the period of 1913-1950. The World War II and related shocks slowed down

economic growth. Spain and Greece, the other two countries with high obesity rates today, had very poor economic growth during that period as well, but they started from a very low level of GDP in the beginning of the century, and still remain below the SHARE average GDP. The data are suggestive of the potential role that economic wellbeing during childhood and prenatal years of the respondents may affect their weight in later life. This may accord with findings in the literature on the relationship between malnutrition among mothers and body weight of children in adult years.

Decomposition Analysis of Contributors to Obesity

Decomposing and comparing contributions of the key behavioral and socio-economic risk factors for obesity, I find that low education appears to have the most influential effect. Lack of secondary or higher education may explain on average about 16% of obesity rates in men and 19% in women. This suggests that, everything else being equal, the prevalence of obesity could be lower by a fifth of the current rates for women and one sixth for men if everyone in the population had at least secondary education (Table 16). The effects vary substantially by country that primarily reflects large differences in the prevalence of risk factors for obesity across countries (e.g., 80% of men in Spain vs. 15% of men in Denmark have attained at most primary education). Differences in the effects of risk factors, which are small and not statistically significant, play a secondary role.

Lack of regular moderate or vigorous physical activity accounts on average for about 9% of obesity rates among women and 2% among men. The larger effect for women is due to both higher prevalence of physical inactivity and larger obesity risks associated with lack of physical activity. On the other hand, smoking in the past is

associated with about 8% of the obesity prevalence in men and only 1% among women. The contribution of current smoking to lower obesity rates is the same 4% for men and women. Finally, low income plays a more important role for women, and explains on average about 7% of obesity rates among women and 3% among men in the SHARE countries. The effect varies by country, playing a very little role in obesity in less wealthy countries like Spain and Greece (1-2%). These countries however have substantial differences in obesity rates by education.

5. CONCLUSIONS

In this paper I use comparable data in 10 countries to ascertain risk factors for obesity at the individual and country level, and evaluate the extent of their contributions to differential rates of obesity among Europeans aged 50 and above. I examine whether the gradient of obesity and its risk factors is similar across countries or whether institutional, cultural, and socio-demographic differences throughout Europe modify that relationship. I further investigate how differences in the prevalence of risk factors for obesity can explain the observed heterogeneity in obesity rates across nations.

Based on nationally representative large samples, I provide estimates of the strong positive association between lack of physical activity and obesity, particularly among women. Women not participating in any regular physical activity are twice as likely to be obese as women engaging in moderate or vigorous physical activity more than once a week. It appears that even moderate-intensity physical activities, independent of participation in other vigorous physical activities, can make a significant difference in terms of obesity among women. In comparison to sports, moderate physical activity like

walking arguably has fewer health constraints, as well as financial and perhaps access limitations (at least in most parts of Europe). Many older people have the ability to engage in moderate physical activity with potential benefits for preventing obesity.

The data on food expenditure, revealing few clear patterns in relation to obesity, is a crude measure of food consumption because it reflects both prices and quantity of food. Descriptive results on higher spending on food relative to income among obese respondents are likely to reflect primarily lower income in this group. One contribution of this research is to demonstrate potential differences in the culture of food consumption and the mechanism of weight gain due to food factors between many European nations and the U.S. Obese respondents in Europe eat primarily at home, so that modifying their home diet would be a key mechanism to affect weight. At the same time, rising trends in food consumed away from home, particularly fast food, has been repeatedly linked to the obesity epidemic in the U.S. (Chou et al. 2004, French et al. 2001, Kant 2000). Food consumed outside home is shown to be on average more caloric-dense and less nutritious (Lin et al. 1999, McCrory et al. 1999, WHO 2003).

As in other populations and studies, low SES is predictive of higher obesity rates in older Europeans too. The SES effects come mainly from low education (controlling for income), especially among men. Obesity differs more by education than by physical activity status and especially income. The role of income is more important for obesity in women than men, but it is still lower of the obesity-related effects attributable to physical inactivity or lack of high education.

The obesity-SES gradient does not vary systematically across SHARE countries. This study found no evidence that institutional and cultural differences across European

nations attenuate or exacerbate the effect of education and income on obesity. The slope of the relation between physical activity and obesity is also statistically equivalent across countries. Further research based on larger datasets is desirable to assess whether such findings are due to lack of statistical power (as might be an issue in this analysis) or reflect comparable effects of obesity risk factors that hold across countries and population groups (as I tend to believe).

I explore how the effects of physical inactivity and low SES on obesity are related to country characteristics (GDP per capita, total health expenditure, food availability) and selected population features (prevalence of obesity, physical inactivity, low education, and smoking). No clear pattern is apparent between the gradient of obesity with its risk factors and country characteristics (Appendix, Table A15). Correlations that are significant suggest mixed messages for men and women. For example, the effect of low education among men is smaller in wealthier countries, but this pattern is not apparent for obesity in women, as well as in the income or physical activity gradient. Similarly, the effects of physical inactivity on obesity are lower in the countries with prevalent physical inactivity for men, but the opposite is true among women.

Institutions and social patterns may account for the observed large heterogeneity in the prevalence of obesity across countries. Low education explains about one fifth of obesity prevalence in women and one-sixth in men, exceeding the attendant contributions of other behavioral and societal risk factors. Had the countries lower differences in the socio-demographic composition of older populations, particularly by education, the gap in obesity rates across countries could have been notably smaller. Future research could establish if cross-country differences in obesity rates are less dramatic in the general

population and younger adults where education differences across nations should be lower than in SHARE.

Limitations

As discussed in Chapter 1, this analysis is essentially descriptive with limitations that a cross-section study has for causal interpretations of the links between obesity and its risk factors. Cross-national observations of this study are nevertheless valuable for understanding the correlates of obesity in older Europeans and their comparability across countries, including the U.S. Another contribution of this cross-national research is its ability to predict outcomes across nations, risk factors, and their interactions.

Other limitations of the study are related to the data and measures. The first concern is reliance on the self-reported data of body weight and height that understates the prevalence of obesity. Another data issue is related to the measures of physical activity, which are also self-reports, and aggregate the frequency and intensity of leisure-time and occupational physical activity. The accuracy of estimations could be notably higher if the survey collected data on the duration of physical activities, number of days participating in sports, and specific types of leisure-time exercise. Similarly, the data on food expenditure has a number of limitations. It is self-reported with a number of missing or potentially inaccurate responses. There are also valid concerns about comparability of education data across countries. For example, countries differ in the number of years required for attaining complete education at a particular level. The quality of education most likely varies across countries. With respect to macro-data on food consumption, food prices and GDP per capita, obvious limitations include generalizations to the

average person in the population that ignore the age variation in food consumption (children, adults and the elderly have different needs of dietary energy), geographic variation in prices and economic well-being (across and within regions and cities).

The study results have the following implications for policy. Education appears to play a key role in explaining differences in obesity among SHARE respondents, yet behavioral factors like physical activity are very important as well. These factors can be modified through changes in incentives and information. They are arguably more responsive to policy initiatives than more structural factors like education or income status. Eliminating the lack of physical inactivity in older women, for example, could reduce obesity rates on average almost by 10%. In terms of health benefits this would imply a reduction of approximately 1 percentage point in disability and diabetes rates and 3 percentage points in poor general health among women. These changes could lead to substantial savings in health care expenditure and disability benefits. Such improvements in health and welfare could be attained by engaging in physical activity that is moderately intensive and available to most adults even with some health constraints. The message for health care providers is that regular moderate physical activity should be promoted as an important tool in preventing weight gain and the development of obesity, particularly among women. The implications for the dietary factors are limited by problems in the data on food expenditure. They however suggest that the obese in Europe mainly eat at home. It is likely that the mechanism of the food-related weight gain is different between many European populations and the U.S.

CHAPTER 4 – Discussion and Policy Implications: Policy Approaches to Obesity Across Countries

This policy review presents a discussion of strategies and approaches around the world for the prevention and management of obesity through public policy. Practices and experiences in different countries are examined along with the analysis of institutional structure, participants, functions, and areas of action in policymaking concerned with obesity control. The review is a summary of policy implications for the matters considered in the preceding two chapters: the effects of and risk factors for excessive body weight in older Europeans.

The case for counteracting obesity is overwhelming, as demonstrated in Chapter 1 by the substantial negative effects of obesity on health and related outcomes. Most in the public health community share the view that the principal causes of the obesity epidemic are over-consumption of energy due to high-calorie diet and a sedentary lifestyle (Chapter 2 speaks to this end). Opinions diverge why these trends have occurred, and how best to address them. The rapid growth in obesity cannot be explained by changes in genes or medical practices. In contrast, the rise in obesity over the past 30 years and significant differences in the prevalence of obesity across countries with similar populations indicate that these trends are environmentally based, and the key causes for obesity spread are societal.

Health officials around the globe have tried different strategies for counteracting obesity with limited impact. Lack of success with long-term efficacy of many treatment therapies for obesity attests that the best long-term approach to the problem of obesity is prevention, particularly in childhood. Evidence to date indicates that obesity prevention is

the most realistic and cost effective approach to addressing obesity in children and adults. Public policy can be a powerful tool in challenging the obesity epidemic by defining effective intervention strategies and increasing investment in health promotion. Comprehensive evidence-based and multi-component action against obesity and policy coordination is key for a success of prevention initiatives. Policymakers, health professionals, and society at large need to join forces in tackling the obesity spread.

Global and National Policies on Obesity Prevention and Management

Approaches to the problem of obesity involve a balance between individual and government responsibilities. Exactly how this responsibility should be built is the subject of active dispute. One strand of researchers, policymakers and society accepts the view that diet and physical activity are under individual or family control. This perspective attributes the major responsibility for making unhealthy lifestyle choices to the individual who has freedom of choice. Another more paternalistic theory suggests that governments have an important role in shaping individual choices. In presenting public policies on obesity prevention and management, this paper shares the view that obesity is a public health problem that is affected by societal and environmental trends, and could be mitigated through effective policymaking.

The global strategies on obesity are shaped by policymaking at the World Health Organization (WHO) and international obesity-focused organizations. Key strategic developments addressing obesity at the WHO include recommendations of the WHO expert consultation in “Obesity: preventing and managing the global epidemic” (2000), and “Diet, nutrition, and the prevention of chronic diseases” (2003). The WHO also

collects and analyzes worldwide data on chronic diseases and their risk factors in the project “Surveillance of chronic disease. Risk factors: country-level data and comparable estimates”. The International Association for the Study of Obesity (IASO), an umbrella organization for national obesity associations with 49 Member Associations from 53 countries, and its partner the International Obesity TaskForce (IOTF) are the other key policymakers to provide a global reach in the area of obesity. They work alongside with the WHO to develop global strategies to tackle the obesity epidemic around the world (IOTF, 2006).

At the European level, addressing obesity is a priority of the European Union (EU) Public Health Action Program for 2003-2008. It plans to fund a EU wide Nutrition and Physical Activity network to facilitate collaboration on obesity prevention strategies. The European platform for Action on Diet, Physical Activity and Health brings together players at the European level, and serves an effective means of non-legislative action. Other EU public health initiatives related to obesity include the Eurodiet project “Nutrition and diet for healthy lifestyles in Europe”, the European network on nutrition and physical activity, the European Prospective Investigation into Cancer and Nutrition (EPIC), and the preparation of WHO-linked nutrition strategies by national governments.

The strategic role of the EU is not to finance major health promotion campaigns, but to support and coordinate the national authorities about policies on obesity control. In some areas, however, the EU has a central decision-making role. The rising concern in European countries about marketing and advertising to children, and need for stricter labeling standards puts pressure on EU governments for stronger action at the EU level. Another EU policy is reform of the Common Agriculture policy (CAP) to promote new

approaches to health protection, such as shifts in agricultural policy to encourage greater consumption of fruit and vegetables, restrictions on food advertisements to children, ban on school-based commercial promotion of foods, and price differentiation in schools and at the workplace to encourage consumption of healthy foods. The EU global partnerships may have a stronger potential than other policymakers to overcome barriers to programs implementation like industry pressure, organizational and political inertia.

Some countries have initiated national programs aimed at reducing obesity. For example, Spain has launched the Strategy for Nutrition, Physical Activity and Obesity Prevention to promote changes in dietary habits and to increase physical activity among the Spanish population, targeting children and youth in particular. The strategy employs multiple tactics and approaches likely to affect obesity, such as regulation of foods with ingredients known to contribute to obesity, control of vending machine access and contents, and nutrition education. Reforms are planned at all levels starting from schools with increasing physical education, restricting access of children and adolescents to high-calorie/high fat food, informing families about the benefits of a balanced diet and an active lifestyle through educational campaigns in the various media tools. The Strategy actively collaborates with many private sector entities, including large supermarkets, health professionals, and the Federation of the Food and Beverage Industry. As a result, actual measures are being implemented at the industry level, like reducing sodium levels in bread manufacturing by the Spanish Confederation of Bread Organizations. As a monitoring mechanism, the Strategy creates an "Observatory of Obesity" to review interventions and target achievement on a regular basis (European Observatory on Health Systems and Policies, 2006).

The Food and Health Action Plan in the UK is a cross-government action led by the Department of Health to improve public health through better diet. Another cross-government action in the UK led by the Departments of Health and Culture, Media and Sport the Activity Coordination Team aims at increasing mass participation in physical activity. The UK Public Health Action program and its annual work plans develop strategies aimed at reducing obesity. The responses to the obesity epidemic in the U.S. are reflected in the growing consumer reaction like mobilization of children's campaign groups and school boards adopting healthy food regulations. Examples of policy action in other countries include stringent labeling proposals in Latin America, consumer lawyers' action against Coca Cola and Pepsi to stop marketing to children in Brazil, and 10 years of high-profile exercise campaigns in Singapore.

Areas of Action

The obesity prevention literature identifies the key areas of public policy action aimed at reducing obesity, as discussed below (Kunanyika et al. 2002, Lissau et al. 2002, Lobstein et al. 2004, WHO 2000).

Addressing the Environmental Factors

Transportation policy, urban design, and city planning are key mechanisms to build environment, which is not contributing to the development of obesity. Community and national programs to ensure the safety and convenience of recreational areas, cycle lanes and pedestrian sidewalks, and to introduce urban congestion charging schemes and restrictions on car access in cities may promote greater use of public transportation and

physically active modes of transportation, several of them at low expense. At the same time, some urban design changes may require decades to implement and have an impact on individual behavior.

Changes in the food sector have a strong potential to help people improve their dietary choices. Promotion of the wider inclusion of less-calorie dense meals and calorie-reducing techniques by food service operators should focus on menu items popular among consumers with consideration of operational constraints of cooking methods and approaches. Food service providers could develop serving techniques that would use portion sizes and menu options to help consumers balance their energy intake, and at the same time maintain profitability of food businesses. The initiatives to improve nutritional choices among consumers include the provision of low-calorie or zero-calorie drink choices and a wider array of beverage sizes, reasonable portions, and flexible pricing mechanisms for lower-calorie food and beverage options.

Consumer Education

There are two issues related to consumer education about nutrition and obesity. First, the sources of most nutritional health information for consumers are commercial that often give conflicting messages and dietary advice. Numerous magazines and a rapidly growing list of book titles propose new weight loss diets almost daily, often ahead of any scientific evidence regarding the efficacy of such diets. One way to enable consumers to make better food choices is to establish common nutritional standards throughout the market, such as a comprehensible but clear labeling scheme. This is the area of institutional action for national governments.

Second, a delivery of nutritional messages to consumers is not sufficient to ensure the intended behavioral response. The key nutritional messages are generally known, but the awareness has little impact on many consumers. New effective mediums of health education at the national, state and local level are needed. They should take into account significant heterogeneity among consumers, including cultural, ethnic, and social differences. Healthy lifestyle education campaigns could also be improved by using a combination of social marketing campaigns and consumer education programs.

Consumer Information, Marketing and Advertising

In addition to food prices, these three factors are important determinants of consumption, although the significance of their role varies by population group. In terms of information, consumers need a consistent and clear approach endorsed by independent authorities like the Foods Standard Agency in Europe. One example of such initiatives is the expected introduction of the traffic light labeling scheme, which is currently under consideration in Europe. It will use color-coding to indicate levels of key nutrients like fat, saturated fat, sugar and salt, and provide information on the levels of nutrients per portion of product rather than the currently used average daily consumption.

The mandatory provision of food labeling in away-from-home food establishments has been discussed actively in many countries. Some food service operators followed suit (selected McDonald's outlets), and introduced food labeling of their products voluntarily. The data are now being collected to investigate how this move affected food choices, and whether consumers read and understand the nutrition information. The perspective of most stakeholders is that calorie information in a

standard and comprehensible format should be easily available to consumers at all food service vendors. This may be a challenge to implement at single-store food venues and small vendors, but a feasible solution at big chains that supply a substantial part of food-away from home services reaching many consumers.

Information on consumer nutritional interests, attitudes and behaviors is another domain where the potential for action exceeds the current use by the public and policymakers. This information is often commercial and not available to the public. Developing ways to improve publicly available knowledge about food consumption behavior and attitudes, including data collection, analysis and public distribution should be a high priority on the research and policy agenda.

In terms of advertising and marketing, the industry representatives oppose changes in the current regulatory system arguing that individual advertisements do not violate specific health concerns. In reality, existing marketing codes exploit children's vulnerability to advertising and their inability to view it from a critical perspective. National initiatives to prevent food and drink advertising to children, particularly among pre-school children, are either under consideration (UK) or have been implemented in Europe (Sweden and Norway). Cross-border broadcasting limits the effectiveness of national bans on TV advertisement to children. The most effective measure to protect children through regulation of food marketing is to have a standard policy prohibiting marketing to children at the EU level in Europe or the federal level in the U.S. New marketing tools via the Internet and cell phone messaging, evading limitations placed on TV advertising, present an even more difficult challenge to regulators.

Alternative ways to government regulation of the food marketing industry do not appear to be effective. For example, the U.S. Children's Advertising Review Unit (CARU) funded by members of the industry maintains self-regulatory guidelines for children's advertising. Evidence to date shows that voluntary codes (self-regulation within industry) have repeatedly failed to adequately regulate advertising and marketing to children. CARU has recently announced an extensive review of its guidelines in collaboration with representatives of the public and civic sectors, which may improve the current situation.

Food Availability, Physical Activity and Health Education at the Workplace

Employers can improve diet and physical activity patterns of their employees by offering healthy food choices at workplace canteens, encouraging physical activity during breaks, and commuting to/from work. Ways to increase physical activity could vary from relatively less-costly approaches like distancing car parks from workplaces to more expensive options, such as building exercise and recreation areas or subsidizing gym membership fees. Other potential actions to facilitate weight management include the promotion of stairs use, incentives for employers cycling or walking to work, and subsidizing healthier food choices. The provision of free vegetables or salads with a workplace meal is the approach adopted in Finland. There is also potential for using preferential health insurance rates for employees with healthy lifestyles (no smoking, regular physical activity, stable weight).

Building Obesity Prevention and Treatment into Medical Services

Medical professionals can influence individual diet and physical activity choices. By advocating reduced consumption of high fat/energy dense food and sugary drinks and increased levels of physical activity among patients, particularly those susceptible to weight gain, health professionals could serve an effective medium of health education and information provision. Professional training, education and research in the field of obesity is another important domain through which health care systems can address the issues of obesity prevention and treatment. This includes certification of obesity professional education, development and authorization of clinical guidelines for bariatric surgery, pharmaceutical treatment, behavioral, and dietary interventions. Coordination of these activities should integrate recommendations and guidelines from the international bodies like the WHO and IASO. Standard approaches at the EU level in Europe and the federal level in the U.S. promise to be the most effective.

Focus on Children

Policy initiatives for the prevention of obesity in children focus on methods to prohibit marketing of foods and drinks to children, improve the nutritional value of school meals, and develop physical activity education for school and pre-school children. Removal of fast food and sugary drinks from school canteens and vending machines, and the provision of healthier meals is a legal requirement in a number of countries (e.g., France, Ukraine, UK, Belgium, some U.S. states). Similar proposals are under consideration in other countries (e.g., Russia, Latvia). Limiting access to soft drinks on school premises is a recent move supported by soft drink vendors in the U.S. Some

countries implemented municipal initiatives to promote the use of local produce that provides fresh ingredients for healthier diets (Italy and the UK).

Socio-Economic Inequalities

There are external and internal aspects of social inequalities in the obesity distribution. Long-term physiological effects of low socio-economic status (SES), which are transferred between generations, may be difficult to correct by promoting behavioral changes in diet and physical activity. A policy response to the issue of social deprivation would require many years and perhaps generations along with substantial social reform and active engagement of society at large. At the same time, environment factors are very important in the development of obesity among disadvantaged population groups. Access to healthy food and safe areas for physical activity is often limited to people of low SES. Relative prices of healthy food vis-à-vis high fat/energy dense products give economic incentives for people of lower SES to make food choices promoting obesity. External factors can be addressed through policy initiatives like the distribution of fruit and vegetables at prices attractive to consumers compared to less healthy alternatives, the provision of free or subsidized healthy meals in schools and the workplace in poorer communities, and the construction of safe recreation areas and sport facilities in less wealthy neighborhoods.

Economic Policy: Taxation and Subsidies

Taxes and subsidies could be another area of government action to address the obesity epidemic. One set of tax proposals suggests imposing junk food taxes, e.g. a

small unit tax per can of soda. Junk food taxes were implemented in the past in a number of American states, although many enacted them not due to health concerns about impacts of such foods but as a good source of tax revenue. Largely under the influence of the food and beverage industry, some states later repealed these taxes (Jacobson and Brownell 2000). Advocates propose extending junk food taxes as a way to fund public health initiatives concerning diet and exercise. Small taxes on junk foods with tax revenues spent on funding health education programs may have better consumer support and political appeal than high taxes explicitly aimed at limiting consumption of some products (Strnad 2004). Another set of tax proposals advocates enactment of "fat taxes" that would apply to fatty foods or to the fat content of foods. Some proposals go beyond the fat content and suggest taxing unhealthful food and subsidizing healthy foods (Battle and Brownell 1996). In contrast to junk food taxes, fat taxes explicitly try to change individual behavior to meet public health goals. As a result, political consideration and consumers' support are important barriers on the way to enact "fat taxes". At the same time, the impact of such taxes on food consumption and related distributional issues are unknown and need further investigation.

Examples of Current Action to Help Tackle Overweight and Obesity

The initiatives to increase consumption of fruit and vegetables in the general population are exemplified by the 5 A Day Program in the UK and the national 5 A Day for Better Health program in the U.S. There are also a number of national initiatives focusing on specific population groups like children or low-income families. The UK National School Fruit Scheme provides a free piece of fruit each school day to over 2

million 4-7 year old children in state primary schools. The Milk Matters program at the National Institute of Child Health and Human Development and the Powerful Bones, Powerful Girls program at the Centers for Disease Control and Prevention are examples of the U.S. initiatives. The programs aim at developing skills for selecting food and drinks away from home, and promoting the intake of three daily servings of low-fat and nonfat milk and milk products, as recommended in the 2005 Dietary Guidelines for Americans (HHS and USDA, 2005). Addressing social inequalities in obesity is the objective of reforming the Welfare Food Scheme in the UK. Launched in 2004, the national program Healthy Start provides the means for disadvantaged families to buy fruit and vegetables. Sure Start is a program focusing on families and children up to age 4 living in the most deprived areas. It gives access to family support, advice on nurturing, and health care services.

Examples of school-based nutritional initiatives implemented in some countries include the use of compulsory nutrition standards for school lunches, recommendations to teach food preparation, cooking and hygiene to children at primary schools, curriculum-mandated regular physical education, investment in building/refurbishing school sports facilities to be also available for community use, and nationwide schemes to encourage children and adolescents to participate in sport (e.g., Positive Futures in the UK).

Policies to promote breastfeeding are initiated in many countries, particularly in Scandinavian nations and the UK. The goal of such initiatives is to encourage women to breastfeed and continue breastfeeding for at least 6 months. A focus on women from disadvantaged groups is typical of most programs. A number of national and local programs encourage adoption of an active lifestyle. For example, to promote physical

activity and walking, government authorities distributed pedometers to communities (UK, US). There were changes to the contracts with physicians to require medical practices to offer health promotion advice to patients (UK). There is ongoing research in several countries on whether a tax on fatty foods (a "fat tax") would provide an incentive to the industry to reduce the fat contents of its products, and raise revenue for health promotion projects. It involves an evaluation of potential effects of different fiscal options on food consumption across population groups.

The corporate sector has also responded to the rising problem of obesity. The industry is working with government authorities in health departments and food standardization agencies to reduce the fat and sugar content of some products. Perhaps motivated by fear of litigation and/or anticipation of changes in consumer demand, some food companies have announced their intention to lower the sugar/fat levels of products, increase the selection of low-calorie meals, or reduce portion sizes. For example, Kraft has declared its global initiative to help address the growth in obesity through a new Worldwide Health and Wellness Advisory Council. McDonald's has named Global Advisory Council on Healthy Lifestyles, whereas Coca Cola has launched a new no targeting policy for children under age 12. The U.S. soft drink companies have signed a deal on limiting soft drinks in vending machines on school premises.

Government efforts to improve knowledge of food behaviors and attitudes among consumers have initiated a number of programs to collect and analyze food-related data on the national scale. In the U.S., such programs include the National Health and Nutrition Examination Survey (NHANES) conducted by the CDC, the Behavioral Risk Factor Surveillance Survey (BRFSS) conducted by state health departments with support

from the CDC, a survey What We Eat in America conducted by the USDA, the Diet and Health Knowledge Survey (DHKS) conducted by the USDA, the Health and Diet Survey conducted by the FDA, the American Time Use Survey (ATUS) conducted by the Department of Labor, the Continuing Survey of Food Intakes by Individuals (CSFII) conducted by the CDC as part of NHANES, and the Early Childhood Longitudinal Study (ECLS) conducted by the Department of Education. At the international level, the WHO provides country-level data on overweight, obesity and physical activity, including databases of the International Obesity TaskForce.

Interventions

A significant body of disappointing evidence on the long-term efficacy of treatment strategies for obesity can be contrasted with more positive evidence on prevention, particularly in childhood. Most reviews have indicated that obesity prevention is possible, and it is also the most realistic and cost effective approach to childhood and adult obesity (Dietz et al. 2001, Ebbeling et al. 2002, Kunanyika et al. 2002, Lissau et al. 2002, WHO 2000). Critical to obesity prevention is improving diet through reduced intakes of fat and added sugar and increasing physical activity levels, so that interventions focus on dietary behavior, physical activity or their combination.

Development and implementation of obesity preventive strategies has multiple stages starting from basic medical research to pilot trials in applied research, community-based demonstrations, and finally large-scale prevention projects. To implement a trial intervention effectively, the research stage should provide accurate medical and epidemiological knowledge, sound behavioral and social theory, and estimates of a dose-

response. Interventions integrated in the community, social structures and industry are likely to be the most effective at the implementation stage. Coordination of initiatives and policies across all participants is essential at all stages.

A review of preventive strategies implemented in different countries showed that small-scale preventive activities have only modest effects on averting obesity in children and adults (Lobstein et al. 2004). Large-scale approaches based on sound theory and community involvement need to be taken to implement changes in the environment, and lead to favorable modifications in dietary habits. Major national demonstration programs in the past have attested that a theory-driven and community-based comprehensive program can be a powerful tool in modifying dietary behavior.

Perhaps the most illustrative example of the effective large-scale interventions to change dietary habits is the North Karelia Project in Finland that started in one province in 1972 and was extended nationwide in 1977. Its goal was to prevent cardiovascular disease and other non-communicable diseases among residents of the province and country. The project has demonstrated that preventive strategies can be effective and pay off, as changes in the population diet led to substantial reductions in heart disease mortality in Finland. Between 1969 and 1995, age-adjusted coronary heart disease mortality declined by 65% for 35-64 year old males in all Finland and by 73% in North Karelia where the project originated (Puska 1999). Similar declines in CHD mortality during this period were seen in other developed countries as well, for example, about a 60% decline in mortality from CVD in the U.S. (Fox et al. 2004, Sytkowski et al. 1990). During the original project period (1972-1977) the decline in CHD mortality was

significantly greater in North Karelia than in the rest of Finland, and the national decline has accelerated thereafter (Puska 1999).

The intervention has involved multiple sectors and settings to implement comprehensive community-based strategies to change dietary habits and risky behaviors. The community-based approach was seen as the most promising setting to challenge dietary habits rooted in the community due to cultural, agricultural and economic reasons (Puska 1999). Development of a thorough evaluation system to assess changes in different indicators was another important feature of the project. Finally, the key project components were involvement of public health nurses and physicians and various community organizations, as well as close collaboration with food and agriculture industry.

In particular, medical professionals received guidelines to help modify risk factors of their patients, community leaders became project assistants, and worksites and TV broadcasts ran significant health promotion efforts. National contests between villages and schools were a popular means of promoting reductions in smoking or changes in dietary habits ("quit and win", cholesterol-lowering contests). The North Karelia Project has also contributed to health promotion training and outreach worldwide. It became affiliated with and assisted in the development of the WHO's InterHealth and Countrywide Integrated Non-communicable Diseases Intervention (CINDI) projects.

The number of programs aimed at prevention of non-communicable diseases including obesity is substantial around the world. For example, the G8 Promoting Heart Health initiative, which disseminates best practices for implementation of cardiovascular disease preventive interventions, lists 167 programs across countries that aim at changing

individual behavior to improve health, particularly heart health (http://www.med.mun.ca/g8hearthealth/pages/list_projects.htm). The following programs represent the most relevant interventions to increase physical activity and improve diet across countries: Active for Life (Australia, UK) Weight Reduction Program in Primary Health Care Settings (Malta), Active and Safe Routes to School (Canada), Community Nutrition Advocate Program (Canada), Eat Smart: The Heart Beat Cafeteria Program (Canada), The Sports for Life Program (Singapore), APPLES (UK), Trim and Fit (Singapore), and Promoting Physical Activity: A Practical Approach (UK).

Data on the effectiveness of treatment interventions is substantial and expanding rapidly through the inclusion of relatively new areas of obesity treatment, such as booming in popularity bariatric surgery and pharmaceutical therapy, findings from genetic and epigenetic[1] research. The evidence on behavioral interventions indicates the highest efficacy of group-based, multi-component strategies to produce weight loss among adults, for example, by promoting improved dietary intake and increased physical activity. Most nutrition interventions for adults include an average of two components like behavioral counseling and nutrition education. Combination nutrition and physical activity interventions have on average three components: behavioral counseling, nutrition education, and exercise assignment. Neither of these components stands out as superior to others. A combination of strategies is the most beneficial approach to maximize the loss of excessive body weight in adults (Lobstein et al. 2004). Even a modest weight loss can substantially improve the health of people who are already overweight or obese.

[1] Epigenetics is the study of reversible heritable changes in gene function that occur without a change in the sequence of nuclear DNA. Environmentally dependent forms of cellular inheritance are sometimes referred to as epigenetic (http://en.wikipedia.org/wiki/Epigenetics).

Dietary modification is a widely used intervention to challenge excessive body weight. A substantial number of diets are employed despite the limited data on their efficacy in reducing body weight, especially the long-term consequences and weight sustainability. For example, the synthesis of 107 studies on 94 low-carbohydrate ”Atkins” diets did not find evidence to make recommendations for or against the use of such diets based on their efficacy and safety. Low-carbohydrate dieting was not independently predictive of greater weight loss compared with higher-carbohydrate diets. At the same time, diets that restricted calorie intake were associated with weight loss (Bravata et al. 2003). Current knowledge on the long-term effects of diets, as well as their variation across population groups like older individuals or people with chronic health conditions, needs further substantial research investment.

Institutional Capacity and Stakeholders

Stakeholders in the field of obesity prevention and management represent different sectors, settings, and action areas at six institutional levels. Below I give a brief summary of multiple institutional agents and their key functions, policies, and actions related to the problem of obesity:

1. Global/multinational level.

Agents: The World Health Organization (WHO), the International Obesity TaskForce (IOTF), the International Association for the Study of Obesity (IASO), the Global Prevention Alliance, and the International Union of Nutritional Sciences (IUNS).

Functions: Develop guidelines and recommendations in the field of nutrition, physical activity and obesity for all countries; commission expert evaluations; collect,

analyze, and distribute information on lifestyle choices and programs in different countries; coordinate research and policy.

2. Regional level/European Union level

Agents: Six regional WHO offices (for the Americas, Africa, South-East Asia, Europe, the Eastern Mediterranean, and the Western Pacific), the Commission of European Communities, the European Food Safety Authority (EFSA), and the EU Platform on Diet, Physical Activity and Health.

Functions: Develop and implement standard policies on food labeling, food marketing controls, and advertising regulation in all country-members or the region; set research priorities and support cross-country research; regulate and coordinate agriculture, trade, and food policy.

3. National level

Agents: National governments, non-governmental organizations, and the media.

Functions: Develop national school curriculum for health education; regulate food marketing and advertising to children; set food standards for pre-school nurseries, schools, and public sector catering; implement federal/national programs to provide price support for healthy foods; introduce economic incentives to develop and implement sustainable transportation policies; develop and implement federal/national guidelines for health education; govern health policy development; provide research support and surveillance; promote health behaviors through national campaigns and networks; collect health statistics; conduct dietary and risk factor surveys; provide professional medical training in obesity prevention and management; use fiscal policies to make behavioral changes for obesity prevention and management more economically attractive.

4. State/county level

Agents: State governments, county municipalities, state NGOs, and the media.

Functions: Develop and implement school meals policy; fund nutritional programs providing access to healthier foods for disadvantaged population groups; regulate catering establishments by introducing economic incentives and/or using accreditation schemes for service of healthy food in catering operators; use state fiscal policy to promote healthier food consumption; provide nutritional surveillance; regulate food policies and agriculture subsidies; promote positive behavior change in the media, education and health service sites; further advocacy for reform in the field.

5. Regional/local level

Agents: City municipalities, communities, education sites, health care services, employers, and neighborhoods.

Functions: Develop and implement sport promotion programs; facilitate reduced car use and increased walking or bicycle use; implement home gardening projects; regulate retail planning and distribution; develop safe facilities for play and recreational activities; provide education classes in food preparation and diet knowledge; promote access to sport facilities and regulation of cost with subsidization of disadvantaged groups; advocate for action on obesity prevention and management; promote physical activity and healthy diet in health care facilities, workplaces, education and social sites by improving access to exercise and healthy food and subsidizing healthy choices.

6. Home level

Agents: Home, families, and individuals.

Functions: Increase health awareness by obtaining nutritional and health information from health care providers, the media, communities, and education sites; adjust diet and physical activity choices to improve and maintain good health; teach food preparation skills and dietary knowledge to family members; educate family members and particularly children about the importance of healthy lifestyle choices; set an example of healthy living to children with own behavior; learn long-term consequences of current choices; take responsibility for current and future health of yourself and family members.

Conclusion

Obesity is a long-term disease that requires sustained strategies for its effective prevention and management. This review presents comprehensive strategies and approaches around the world for the prevention and management of obesity through public policy. It discusses multiple institutional stakeholders that are dealing with obesity at the global, national, and local level. Their areas of action in tackling the obesity epidemic involve different settings, sectors and components with time and investment needs ranging from short-term inexpensive projects to long-run extensive and costly initiatives.

This dissertation has demonstrated that obesity is associated with critical market failures, which call for government action. The obesity-related market failures include externalities and incomplete information that distort markets and reduce public welfare. Similar to other behavioral habits like smoking or alcohol abuse, the external costs of obesity are substantial, but their origin is different from those of tobacco and alcohol. Obesity does not impact health and welfare of other agents directly like drunk driving

that could kill other people or secondhand smoking that could cause or exacerbate disease in nonsmokers. In contrast, externalities of obesity are accumulated indirectly in excessive medical costs due to obesity-related illnesses, disability payments, and early retirement exits, as shown above. These costs are born by all agents through pooled insurance. Some of the causes of obesity came from environmental factors, like road safety for pedestrians and bicyclists, access to healthy food and exercise in some neighborhoods. Incomplete information is another market failure as reflected in limited knowledge among consumers about health impacts of different foods, long-term consequences of food and exercise choices, and the effectiveness of diets and weight-loss therapies. Government has a role, which private markets could not provide, in addressing the information issues related to obesity to improve social welfare.

The review of obesity policies and strategies in this dissertation has shown that one of key elements of any preventive strategy for obesity is health education and health promotion. This area of action is primarily the responsibility of public authorities. First, there are economies of scale in prevention, so that large-scale government programs may be the most cost-effective means of achieving public health goals. Second, there are positive externalities in health promotion and education activities, which may contribute to reaching public health objectives in other than obesity areas. Third, it may be hard to sell good health education commercially, and information accuracy and reliability could be an issue. The public goods of science and research is another area for public funding to lead. Government also has a special role in investing in children's health, as children often cannot make a mature judgment about food products and energy balance, and may regret their choices later in life.

Another important tool for government intervention is economic policy that uses taxes/ subsidies and regulation of production to improve social welfare. Proposals to tax junk food and/or fatty products, subsidize consumption or production of healthy foods, regulate production and marketing of specific food products, especially to children, are put forward in the U.S. and other developed countries. Addressing the production/supply side of obesity-related factors is critical, as changes in food technology have played a large part in U.S. obesity. The industry would respond to consumer demand for healthy food choices by accommodating new consumer needs, but the government is yet to understand what drives consumer demand for exercise and food, and how to change it to improve public health. In contrast to estimates of the demand for tobacco and alcohol, research in this area for obesity is still in its infancy.

The analysis of policies and programs on obesity worldwide reveals that they have moved away from using the approaches focused exclusively on health education toward identifying the principal forces and processes in the obesity-promoting environment. It appears that the individual awareness approach, which requires a substantial proportion of the population susceptible to obesity to permanently change their behavior, has had little success to date. In addition to the policy shift towards addressing the environmental factors of obesity, this review showed that policy coordination among multiple participants and policymakers working to reduce obesity is critical. Collaborative approaches are important, as some actions may be cost-prohibitive if undertaken individually. Finally, a review of the current programs could not establish whether policymakers and program designers adequately consider the possibility of unintended consequences of obesity policies, and the need for attendant responses.

FIGURES

Figure 1: Adjusted ADL-Disability Rates by BMI and Gender

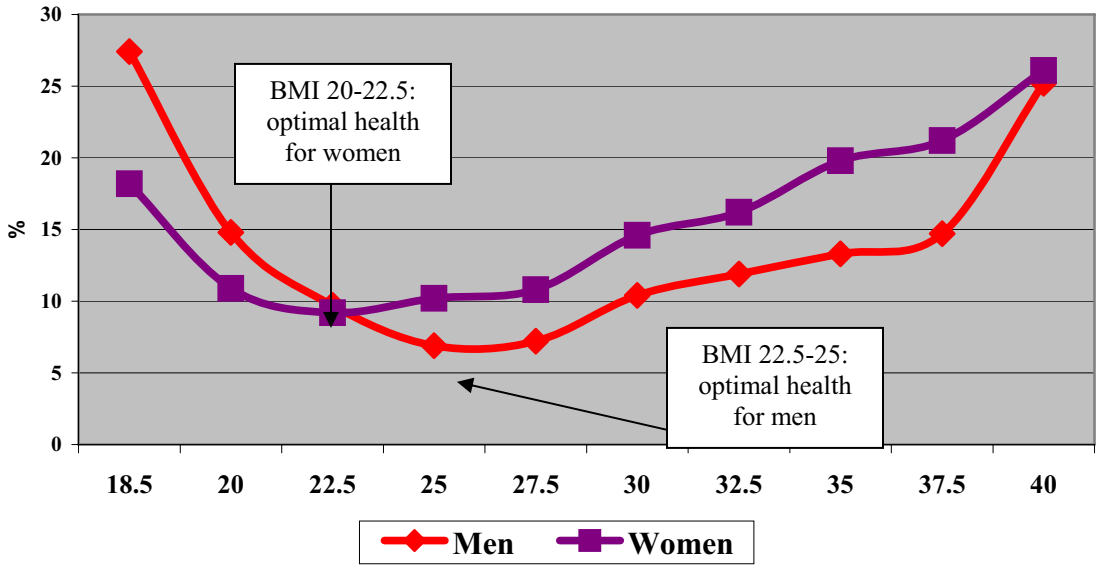
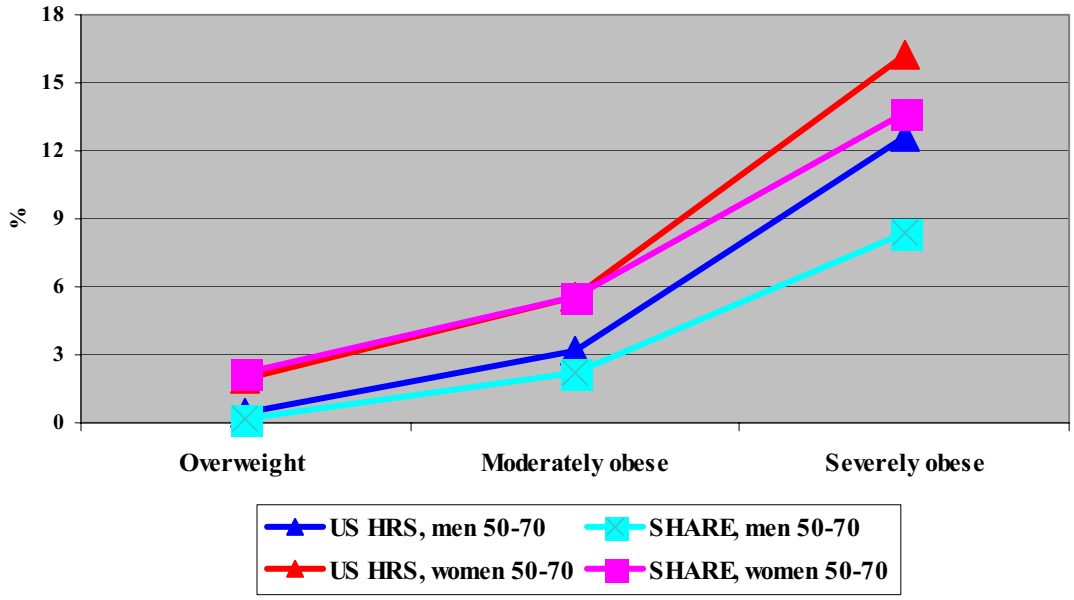


Figure 2: Percentage Increase in ADL-Disability by BMI Group Compared to Normal Weight: US and European Obesity-Health Gradient



TABLES

Table 1: Socio-demographic Characteristics of the Sample by BMI Group

	Sample size	Underweight BMI <18.5	Normal weight BMI 18.5-24.9	Overweight BMI 25-29.9	Moderately obese BMI 30-34.9	Severely obese BMI 35+
Men, N = 9652						
Age						
50-64 years	5180	0.2	32.4	50.9	13.3	3.1
>=65	4472	0.9	34.6	48.6	13.3	2.7
Highest education						
Primary or less	4370	0.6	31.1	49.1	15.5	3.7
Secondary	3150	0.6	32.9	50.9	12.9	2.7
Tertiary	2132	0.0	39.1	49.7	9.5	1.6
Marital status						
Married/ partnered	7879	0.3	32.7	50.5	13.8	2.7
Single/ divorced	1773	0.9	35.6	47.8	11.9	3.7
Smoking status						
Current	2304	0.6	37.8	47.4	11.1	3.1
Past	3913	0.5	29.3	51.9	15.0	3.3
Never	3435	0.4	35.0	49.3	12.9	2.4
Total	*9652*	*0.5*	*33.4*	*49.8*	*13.3*	*2.9*
Women, N = 11,357						
Age, years						
50-64	6088	1.5	45.3	35.2	13.2	4.8
>=65	5269	2.3	43.1	36.9	13.8	3.9
Highest education						
Primary or less	6485	1.8	39.8	37.9	15.5	4.9
Secondary	3143	1.9	45.8	35.8	12.7	3.8
Tertiary	1729	2.5	58.8	28.9	6.8	2.9
Marital status						
Married/ partnered	7290	1.4	43.5	37.3	13.7	4.1
Single/ divorced	4067	2.5	44.8	34.7	13.4	4.6
Smoking status						
Current	1831	4.1	51.9	31.9	9.6	2.6
Past	1997	2.2	44.8	35.1	13.1	4.8
Never	7529	1.5	42.6	37.0	14.3	4.5
Total	*11357*	*1.9*	*44.1*	*36.1*	*13.5*	*4.3*

Note: Data are presented as percentages. The reported estimates are weighted.

Table 2: Distribution of BMI Groups by Country

	Sample size	Underweight BMI <18.5	Normal weight BMI 18.5-24.9	Overweight BMI 25-29.9	Moderately obese BMI 30-34.9	Severely obese BMI 35+
Men, N = 9652						
Austria	798	0.3	29.8*	51.9	14.5	3.4
Denmark	735	0.6	40.1**	45.3*	11.8	2.2
France	734	0.6	36.0	48.3	12.3	2.8
Germany	1352	0.4	31.7	50.9	14.0	2.9
Greece	877	0.1*	28.6**	54.5*	14.5	2.3
Italy	1106	0.6	34.1	50.1	12.4	2.8
Netherlands	1314	0.3	38.1**	48.5	11.1*	1.9*
Spain	937	0.6	29.2**	49.9	16.2*	4.0
Sweden	1368	0.6	39.5**	47.1	10.4**	2.4
Switzerland	431	0.4	39.9**	46.6	11.1	1.9
Total	*9652*	*0.5*	*33.4*	*49.8*	*13.3*	*2.9*
Women, N =11,357						
Austria	1069	1.5	43.4	35.4	15.9*	3.8
Denmark	834	4.2**	51.5**	31.0**	10.9*	2.4**
France	891	3.6**	51.2**	30.1**	11.2*	3.9
Germany	1539	1.2*	43.6	37.8	13.2	4.2
Greece	1033	0.9*	35.2**	41.9**	16.9**	5.0
Italy	1347	2.3	44.3	36.4	13.7	3.4
Netherlands	1436	1.4	46.1	36.0	12.1	4.4
Spain	1218	0.5**	32.4**	41.5**	18.1**	7.5**
Sweden	1524	2.2	49.5**	33.8	11.6*	2.8**
Switzerland	466	3.4	55.3**	29.1**	9.4**	2.9
Total	*11357*	*1.9*	*44.1*	*36.1*	*13.5*	*4.3*

Note: Data are presented as percentages. The reported estimates are weighted.

* Significantly different from the sample mean at the 5% level.
** Significantly different from the sample mean at the 1% level.

Table 3: Prevalence of Obesity-Related Health Outcomes by Country

	Poor/fair self-reported health	ADL-disability	Diabetes	High cholesterol	Hypertension	Arthritis	Heart disease	Depression
				Men, N=9652				
Austria	27.7*	8.1	9.9	16.9	27.0*	7.9**	11.5	12.4**
Denmark	24.0**	9.5	8.1**	17.4	30.7	19.4**	9.7**	13.9*
France	31.1	12.8**	10.8	23.2**	26.9**	23.5**	17.0**	21.9**
Germany	37.1**	8.3	11.0	18.1	33.5*	9.1**	13.5	12.6**
Greece	25.2**	6.4**	8.6**	19.5	32.2	9.6**	14.9	12.8**
Italy	32.3	9.7	12.6	17.3	36.6**	18.8**	11.4	23.4**
Netherlands	25.4**	6.3**	7.8**	16.3**	22.5**	5.5**	13.4	15.8
Spain	34.4	9.2	14.3**	22.9*	26.7**	18.8**	11.4	20.9*
Sweden	10.6**	7.8	9.8	16.4**	27.6*	5.9**	20.1**	12.7**
Switzerland	13.8**	4.4**	7.2**	15.7*	28.7	7.1**	8.5**	11.2**
Total	*31.7*	*9.3*	*11.3*	*19.4*	*30.9*	*14.9*	*13.5*	*17.8*
				Women, N=11357				
Austria	30.7**	11.5	8.1**	15.6**	34.3	13.4**	7.9	26.0**
Denmark	25.3**	10.1	6.7**	13.7**	28.4**	32.5**	7.4*	21.6**
France	35.4**	12.5	7.9**	25.9**	33.3	38.1**	10.5	42.5**
Germany	42.4*	12.1	12.9**	18.8	38.2*	14.4**	10.1	27.4**
Greece	36.6	11.5	8.9	22.1	41.1**	25.1	9.9	34.8
Italy	45.6**	12.5	11.1	19.7	36.2	36.6**	8.0	40.5**
Netherlands	28.6**	9.5*	8.7*	13.3**	27.6**	13.5**	8.1	25.4**
Spain	47.6**	13.2	13.1*	25.0**	37.6	35.0**	10.6	46.1**
Sweden	15.4**	11.7	7.8**	16.4**	29.4**	13.8**	14.6**	27.3**
Switzerland	17.8**	8.3**	4.1**	9.8**	23.2**	14.8**	5.2**	23.1**
Total	*39.6*	*12.1*	*10.7*	*20.5*	*35.5*	*26.8*	*9.6*	*35.4*

Note: Data are presented as percentages. The reported estimates are weighted.

- Significantly different from the sample mean at the 5% level.
- ** Significantly different from the sample mean at the 1% level.

Table 4: Effects of Obesity on Health, Health Care Outcomes and Labor Force Participation Among Men Aged 50+

	Underweight BMI <18.5	Normal weight BMI 18.5-24.9	Overweight BMI 25-29.9	Moderately obese BMI 30-34.9	Severely obese BMI 35+
			Health Outcomes, %		
Poor/fair self-reported health	62.1**	30.2	30.1	39.9**	49.6**
ADL-disability	27.4 **	7.9	8.4	12.4**	18.7**
Diabetes	14.7*^	7.5	11.2**	17.9**	24.8**
High blood cholesterol	9.5	15.7	20.8**	22.3**	25.9**
Hypertension	14.6	22.0	31.9**	43.1**	51.5**
Arthritis	15.9	13.6	15.9**	19.3**	21.5**
Heart disease	11.1	12.5	13.7*^	17.8**	17.7*
Depression	47.0**	18.8	17.0*	19.9	25.1*
			Health Care Outcomes (number per annum)		
Doctor visits	10.6	6.3	6.5	7.5**	9.4**
Hospital nights	13.4 (1^{st}*|2^{nd}**)	2.7	2.1 (1^{st}**)	2.7	3.7 (1^{st}*^)
			Labor Force Participation Outcomes, %		
Retired	64.2	57.8	58.3	58.4	58.6
Employed/ self-employed	22.5	34.2	34.4	32.2*^	28.6**
Disabled/ permanently sick	13.3*	2.9	3.2	4.1*	5.7**
Unemployed	0	4.6	3.9	4.9	6.7*^
Homemaker	0	0.5	0.2*	0.4	0.4
Number of observations	*37*	*3270*	*4847*	*1245*	*253*

Note: The reported estimates are adjusted for age, education, income (health and health care outcomes only), marital status, and smoking. Country fixed effects are included.

** Significantly different from the normal weight group at the 1% level.
* Significantly different from the normal weight group at the 5% level.
*^ Significantly different from the normal weight group at the 10% level

Table 5: Effects of Obesity on Health, Health Care Outcomes and Labor Force Participation Among Women Aged 50+

	Underweight BMI <18.5	Normal weight BMI 18.5-24.9	Overweight BMI 25-29.9	Moderately obese BMI 30-34.9	Severely obese BMI 35+
			Health Outcomes, %		
Poor/fair self-reported health	51.1**	33.8	38.8**	50.4**	63.9**
ADL-disability	18.2*	9.9	12.3**	17.3**	27.3**
Diabetes	3.9	6.2	11.0**	18.5**	27.1**
High blood cholesterol	10.2**	18.2	21.7**	23.7**	24.1**
Hypertension	17.5**	27.2	39.8**	48.9**	61.4**
Arthritis	19.7	24.4	27.9**	34.3**	40.9**
Heart disease	8.9	8.2	9.8**	13.1**	14.7**
Depression	40.6*	33.4	34.9	40.2**	48.9**
			Health Care Outcomes (number per annum)		
Doctor visits	7.5	7.8	8.2*	9.4**	10.4**
Hospital nights	4.9 (1^{st}*|2^{nd}**)	1.9	2.1 (1^{st}*)	3.0 (1^{st}**|2^{nd}*)	4.1 (1^{st}**|2^{nd}*)
			Labor Force Participation Outcomes, %		
Retired	47.8**	45.7	47.1	48.2**	49.6**
Employed/ self-employed	17.6*	21.9	20.0**	18.0**	16.9**
Disabled/ permanently sick	4.9**	2.2	2.1	2.7**	5.3**
Unemployed	2.0	2.4	3.0*	3.4**	2.8
Homemaker	27.6	27.8	27.8	27.6	25.4*
Number of observations	*205*	*4965*	*4147*	*1562*	*478*

Note: The reported estimates are adjusted for age, education, income (health and health care outcomes only), marital status, and smoking. Country fixed effects are included.

** Significantly different from the normal weight group at the 1% level.
* Significantly different from the normal weight group at the 5% level.
*^ Significantly different from the normal weight group at the 10% level.

Table 6: Effects of Obesity on Health, Health Care Outcomes and Labor Force Participation in Men Aged 50+ in Models with Gender-Specific Narrow BMI Groups

	BMI <18.5	BMI 18.5-20	BMI 20-22.5	BMI 22.5-25 (base)	BMI 25-27.5	BMI 27.5-30	BMI 30-32.5	BMI 32.5-35	BMI 35-37.5	BMI 37.5+
					Health Outcomes, %					
Poor/fair health	62.2**	38.1*	34**	28.5	28.2	33.2**	40.3**	39.4**	50.7**	48.1**
ADL-disability	27.4**	14.8**	9.7*	6.9	7.2	10.4**	11.9**	13.3**	14.7**	25.2**
Diabetes	14.7*^	8.7	6.8	7.7	9.9**	13.1**	17.2**	19.7**	24.5**	25.4**
High cholesterol	9.5	6.1**	14.1*^	16.7	19.9**	22.2**	22.0**	22.9**	25.3**	27.1**
Hypertension	14.4	16.5*^	17.5**	23.7	29.2**	36.5**	41.2**	47.5**	50.6**	53.1**
Arthritis	15.9	18.9*^	15.3*^	12.7	15.9**	15.9**	18.6**	20.8**	17.9*^	27.5**
Heart disease	11.0	9.7	12.2	12.7	12.9	14.9*	17.5**	18.5**	15.8	21.1*
Depression	47.2**	24.7*	23.3**	16.9	15.7	19.0*^	19.7*^	20.3	22.2	29.6**
					Health Care Outcomes (number per annum)					
Doctor visits	10.7*^	6.9	6.2	6.7	6.6*^	6.6*^	7.4**	7.9**	8.4**	10.9**
Hospital nights	13.5 (1^{st}*|2^{nd}**)	2.9 (1^{st}*^)	2.7	2.6	2.0 (1^{st}**)	2.3	2.4	3.	3.5	4.2 (1^{st}*)
					Labor Force Participation Outcomes, %					
Retired	64.2	65.6*	57.0	57.7	57.9	58.7	58.3	58.6	56.1	61.9*^
Employed/ self-employed	22.4*^	25.7*	34.7	34.4	35.4	32.9	32.2	32.1	27.9*	28.9*^
Disabled	13.5**	2.8	3.8*^	2.6	2.8	3.5*	3.7*^	4.8**	6.4**	4.6*^
Unemployed	0	5.1	3.9	4.8	3.5	4.5	5.4	3.8	8.8**	4.5
Homemaker	0	0.8	0.5	0.5	0.2	0.3	0.3	0.6	0.7	0
N obs.	*37*	*113*	*803*	*2354*	*3001*	*1846*	*849*	*396*	*152*	*101*

Note: The reported estimates are adjusted for age, education, income (health and health care outcomes only), marital status, and smoking. Country fixed effects are included. ** Significantly different from the base group at the 1% level; *at 5%; *^ at 10%.

Table 7: Effects of Obesity on Health, Health Care Outcomes and Labor Force Participation in Women Aged 50+ in Models with Gender-Specific Narrow BMI Groups

	BMI <18.5	BMI 18.5-20	BMI 20-22.5 (base)	BMI 22.5-25	BMI 25-27.5	BMI 27.5-30	BMI 30-32.5	BMI 32.5-35	BMI 35-37.5	BMI 37.5-40	BMI 40+
						Health Outcomes, %					
Poor/fair health	51.1**	39.5*	33.5	33.1	35.9	43.1**	49.8**	51.8**	60.8**	64.7**	69.1**
ADL-disability	18.2**	10.9	9.2	10.2	10.8*^	14.6**	16.2**	19.8**	21.2**	26.1**	40.4**
Diabetes	3.9	5.5	4.8	7.1**	10.1**	12.4**	16.9**	22.0**	23.3**	27.5**	34.6**
High cholesterol	10.2*	19.7	16.7	19.0*^	21.5**	22.1**	23.7**	23.7**	23.3*	23.6*^	26.2**
Hypertension	17.5*	24.7	23.6	29.8**	37.7**	43.2**	48.2**	50.9**	61.3**	61.0**	62.3**
Arthritis	19.6	22.9	23.7	25.1	26.2*^	30.4**	33.9**	35.0**	36.9**	41.7**	48.3**
Heart disease	8.9	9.5	7.7	8.3	8.6	11.7**	12.5**	14.6**	13.6**	15.6**	16.5**
Depression	40.6*	36.1	32.9	33.3	33.6	36.8*	39.5**	41.8**	44.9**	54.2**	51.9**
						Health Care Outcomes (number per annum)					
Doctor visits	7.5	8.7*^	7.6	7.8	8.1	8.5**	9.1**	10.1*	10.1**	9.9*	11.3**
Hospital nights	4.9 (1^{st}*|2^{nd}**)	3.0 (1^{st}**)	1.7	1.9	1.9	2.3 (1^{st}**)	2.7 (1^{st}*|2^{nd}*)	3.8 (1^{st}**|2^{nd}*)	3.7 (1^{st}**)	5.8 (1^{st}**|2^{nd}*)	3.7 (2^{nd}*^)
						Labor Force Participation Outcomes, %					
Retired	47.8*	43.7	44.5	46.7	46.8	47.5*	47.9*^	48.7*	48.9	47.3	53.0**
Employed/ self-employed	17.6*	20.6	22.1	21.9	20.3*	19.6**	18.5**	17.1**	18.4*	18.3	13.8**
Disabled	4.9**	3*	1.7	2.4	2.2	2.0	2.9**	2.2*^	4.1**	3.2	8.4**
Unemployed	2	1.7	2.4	2.5	2.8*	3.4*^	3.4*	3.5	3.4	1.1	3.1
Homemaker	27.6	31.0	29.2	26.5*	27.9*	27.4*	27.2	28.5*	25.1	30.2	21.6*^
N obs.	*205*	*403*	*1811*	*2751*	*2494*	*1653*	*1072*	*490*	*247*	*106*	*125*

Note: The reported estimates are adjusted for age, education, income (health and health care outcomes only), marital status, and smoking. Country fixed effects are included. ** Significantly different from the base group at the 1% level; *at 5%; *^ at 10%.

Table 8: Decomposing Obesity Contribution to Disease: Percentage of the Condition Prevalence Explained by Obesity, %

Men

	Poor/Fair Self-Reported Health	ADL-Disability	Diabetes	High blood cholesterol	Hypertension	Arthritis	Heart disease	Depression
Austria	8	9	23	11	20	12	11	-3
Denmark	9	15	16	5	8	5	0	3
France	8	14	19	2	9	3	3	2
Germany	6	1	25	7	14	5	10	3
Greece	0	18	14	9	11	8	1	0
Italy	5	11	11	3	7	7	4	6
Netherlands	6	3	10	9	12	5	3	2
Spain	7	-1	10	7	15	10	6	0
Sweden	6	16	19	4	11	1	7	2
Switzerland	8	14	14	2	15	13	6	1
All sample	6	10	17	6	12	7	6	2

Women

	Poor/Fair Self-Reported Health	ADL-Disability	Diabetes	High blood cholesterol	Hypertension	Arthritis	Heart disease	Depression
Austria	12	15	28	9	15	4	11	4
Denmark	8	13	19	6	9	4	14	6
France	9	16	38	2	13	6	12	2
Germany	11	14	26	6	15	10	6	5
Greece	13	12	21	7	11	14	3	5
Italy	7	12	24	1	11	5	8	4
Netherlands	9	14	26	4	10	10	8	2
Spain	9	21	21	5	16	10	21	7
Sweden	16	8	21	6	10	8	6	4
Switzerland	8	13	30	3	18	7	9	8
All sample	9	14	24	5	12	8	10	4

Note: Decomposition calculation based on the methodology in Kapteyn, Smith, Van Soest, 2004. Self-Reported Work Disability in the US and The Netherlands. RAND Working Paper 206.

Table 9: Sample Distribution by Type and Level of Physical Activity, %

Men		**Moderate physical activity**			
		More than once a week	Once a week/ 1-3 times a month	Hardly ever, or never	Total
Vigorous physical activity	More than once a week	33	4	1	38
	Once a week/ 1-3 times a month	14	8	0	22
	Hardly ever, or never	22	9	9	40
	Total	68	21	11	100
	Women	**Moderate physical activity**			
		More than once a week	Once a week/ 1-3 times a month	Hardly ever, or never	Total
Vigorous physical activity	More than once a week	24	3	1	28
	Once a week/ 1-3 times a month	16	5	1	22
	Hardly ever, or never	25	10	15	50
	Total	65	18	17	100

Note: Data weighted to be nationally representative.

Table 10: Sample Distribution by Percentage of Food Expenditure in Household Income and Obesity Status

% of food expenditure in household income	Men		Women		All	
	Non-obese, BMI<30	Obese, BMI>=30	Non-obese, BMI<30	Obese, BMI>=30	Non-obese, BMI<30	Obese, BMI>=30
Less than 5%	9.8	9.5	8.7	6.3	9.2	7.7
5-10%	14.9	11.8	14.5	9.3	14.6	10.4
10-20%	32.5	27.6	29.3	27.1	30.8	27.4
20-30%	19.8	23.4	21.1	25.3	20.5	24.5
30-50%	16.2	16.1	17.4	20.2	16.8	18.4
50% and above	6.8	11.4	9.2	11.8	8.1	11.6

Note: Data weighted to be nationally representative.
N=16,054. Individuals with the share of food expenditure in household income above 1 are excluded.

Table 11: Obesity Rates by Level of Physical Activity, %

		Moderate physical activity			
	Men	More than once a week	Once a week/ 1-3 times a month	Hardly ever, or never	Total
Vigorous physical activity	More than once a week	14	18	11[1]	15
	Once a week/ 1-3 times a month	14	15	24[1]	15
	Hardly ever, or never	20	18	17	19
	Total, column	16	17	16	
		Moderate physical activity			
	Women	More than once a week	Once a week/ 1-3 times a month	Hardly ever, or never	Total
Vigorous physical activity	More than once a week	15	15	20[1]	15
	Once a week/ 1-3 times a month	15	17	22[1]	16
	Hardly ever, or never	19	18	25	20
	Total, column	16	17	24	

Note: Data weighted to be nationally representative.
[1]These estimates are based on a group of 1% of the sample or less.

Table 12: Predicted Obesity Rates by Type and Level of Physical Activity

		Moderate physical activity			
	Men	More than once a week	Once a week/ 1-3 times a month	Hardly ever, or never	Effect of vigorous physical activity independent moderate activity, odds ratio
Vigorous physical activity	More than once a week	14	16	15	Ref.
	Once a week/ 1-3 times a month	14	16	16	1.03
	Hardly ever, or never	19	22	21	1.44**
	Effect of moderate physical activity independent of vigorous activity, odds ratio	Ref.	1.18*	1.11	
		Moderate physical activity			
	Women	More than once a week	Once a week/ 1-3 times a month	Hardly ever, or never	Effect of vigorous physical activity independent moderate activity, odds ratio
Vigorous physical activity	More than once a week	14	19	25	Ref.
	Once a week/ 1-3 times a month	13	18	23	0.93
	Hardly ever, or never	17	21	27	1.24**
	Effect of moderate physical activity independent of vigorous activity, odds ratio	Ref.	1.44**	2.02**	

Note: The reported estimates are adjusted for age, education, income, marital status, and smoking. Country fixed effects are included.

** Significantly different from the base group (physical activity more than once a week) at 1% level.
* Significantly different from the base group (physical activity more than once a week) at 5% level.

Table 13: SES Differences in Obesity Rates Across Countries, %

	Percentage point difference in obesity rates among individuals from lowest and highest income quartile		lowest and highest education level	
	Men	**Women**	**Men**	**Women**
US	2.5*^	16.9**	7.5**	11.6**
Spain	5.0	3.8	11.3**	20.5**
Greece	1.7	3.4	8.9**	-1.1
Austria	2.6	6.3*^	7.8*^	8.7*
Germany	7.9*	9.3**	13.1*	8.9**
Italy	-0.2	8.3*	10.3*	13.7**
France	14.2**	9.1**	8.8**	8.3**
Netherlands	1.3	6.1*	11.1**	7.4**
Denmark	4.2	3.9	10.1*	7.3*
Sweden	-1.1	10.5**	7.5**	6.2**
Switzerland	5.2	5.3	1.9	4.6
All SHARE	5.6**	7.7**	8.0**	10.7**

Note: Data weighted to be nationally representative. The table ranked by obesity prevalence among women.

** Group differences are significant at 1% level; *at 5%; *^ at 10% level.

Table 14: Predicted Obesity Rates by SES, %

	Men	**Women**
Lowest income quartile	18.2	20.6
Second income quartile	16.9	18.1*
Third income quartile	15.5*	16.7**
Highest income quartile	15.2*	14.6**
Primary or no education	19.8	20.2
Secondary education	16.0**	16.4**
Tertiary education	10.5**	11.8**

Note: The reported estimates are adjusted for age, physical activity level, marital status, and smoking. Country fixed effects are included.

** Significantly different from the base group (low income or education) at 1% level; *at 5%.

Table 15: Correlation Coefficients Between Obesity Rates and Country-Level Characteristics

	All	Men	Women
	Price index		
All food	-0.85*	-0.73*	-0.89*
Fruits	-0.79*	-0.62	-0.86*
Vegetables	-0.87*	-0.76*	-0.90*
Soft drinks	-0.64*	-0.59*	-0.65*
Fast food	-0.82*	-0.76*	-0.83*
	Food availability (current)		
Dietary energy/calories	0.33	0.39	0.27
Protein	0.39	0.31	0.41
Fat	0.32	0.42	0.25
	Food availability (past)		
Year 1961	-0.67*	-0.55	-0.72*
Year 1970	-0.47	-0.35	-0.53
Year 1980	-0.14	-0.01	-0.22
Year 1990	0.29	0.31	0.25
	Food availability (trends)		
Growth over 1960's	0.42	0.39	0.42
Growth over 1970's	0.79*	0.78*	0.76*
Growth over 1980's	0.68*	0.56	0.72*
Growth over 1990's	-0.29	-0.18	-0.35
Growth over 1961-2001	0.79*	0.74*	0.79*
	Economic wellbeing in pre-natal / childhood years of SHARE respondents		
GDP per capita 1930	-0.77*	-0.70*	-0.73*
GDP per capita 1940	-0.80*	-0.69*	-0.84*
GDP per capita 1950	-0.89*	-0.82*	-0.89*
GDP growth rate 1913-50	-0.87*	-0.88*	-0.82*
GDP growth rate 1950-73	0.89*	0.86*	0.88*
GDP growth rate 1973-92	0.55	0.64*	0.47
	Economic wellbeing during adult years of life of SHARE respondents		
GDP per capita 1960	-0.85*	-0.74*	-0.88*
GDP per capita 1970	-0.85*	-0.74*	-0.88*
GDP per capita 1980	-0.83*	-0.69*	-0.88*
GDP per capita 1990	-0.78*	-0.62*	-0.85*

Note: Source: Food data from FAO Statistics Division. GDP data from Maddison, 2000.
Food availability above indicates food consumption according to the following definitions:
The dietary energy consumption per person is the amount of food, in kcal per day, for each individual in the total population. The dietary protein consumption per person is the amount of protein in food, in grams per day, for each individual in the total population. The dietary fat consumption per person is the amount of fat in food, in grams per day, for each individual in the total population.

Table 16: Decomposition of Obesity Rates by Country: Percentage of Factor Contribution to Obesity Prevalence, %

Men

Country/ Factor	Lack of any regular physical activity	Low education (primary or none)	Low income	Smoking in the past	Current smoking
Austria	0	3	4	8	-15
Denmark	1	7	5	-3	-16
France	2	13	9	6	-3
Germany	1	4	5	5	-4
Greece	1	26	1	4	-10
Italy	2	35	2	20	0
Netherlands	3	25	2	14	5
Spain	0	43	1	-9	-4
Sweden	1	9	3	13	-4
Switzerland	3	11	13	29	1
All sample	2	16	3	8	-4

Women

Country/ Factor	Lack of any regular physical activity	Low education (primary or none)	Low income	Smoking in the past	Current smoking
Austria	9	11	7	3	-2
Denmark	4	9	8	4	-13
France	13	16	17	2	-4
Germany	8	6	7	2	-5
Greece	3	4	1	1	-8
Italy	12	53	8	3	-5
Netherlands	10	25	10	2	-8
Spain	10	29	2	-2	-1
Sweden	1	22	16	1	-4
Switzerland	1	30	12	4	2
All sample	9	19	7	1	-4

Note: The data shown are estimates of the percentage of obesity rates that are explained on average by each factor (given its prevalence in the population and the effects on obesity in by-country analysis).
Based on methodology in Kapteyn, Smith, van Soest, 2004. Self-Reported Work Disability in the U.S. and The Netherlands. RAND Working Paper: p.7-10.

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Appendix

List of Tables

Table A1: Health, Health Care and Labor Force Participation Outcomes by BMI Group Among Men 50+

	Underweight BMI <18.5	Normal weight BMI 18.5-24.9	Overweight BMI 25-29.9	Moderately obese BMI 30-34.9	Severely obese BMI 35+
			Health Outcomes, %		
Poor health	71.6	28.6	29.6	42.2	49.7
ADL-disability	44.8	8.4	8.6	11.5	15.2
Diabetes	18.0	6.6	11.1	19.9	26.9
High cholesterol	8.5	15.6	21.1	21.9	22.2
Hypertension	20.7	22.3	32.9	42.0	45.1
Arthritis	26.5	13.1	14.9	18.6	16.3
Heart disease	22.6	12.1	13.0	17.9	15.1
Depression	63.3	17.2	16.8	19.8	25.3
			Health Care Outcomes (number per annum)		
Doctor visits	11.5 (14.4)	6.1 (10.2)	6.5 (9.7)	8.2 (11.5)	9.2 (14.9)
Hospital nights	28.8 (31.9)	16.6 (26.7)	11.6 (17.7)	13.4 (15.2)	14.5 (13.9)
			Labor Force Participation Outcomes, %		
Retired	88.8	57.8	58.2	61.3	55.5
Employed/self-employed	1.1	34.5	35.4	29.4	31.5
Disabled	10.1	3.3	2.6	4.2	5.4
Unemployed	0	3.8	3.6	4.5	7.3
Homemaker	0	0.6	0.1	0.6	0.2
Total	*0.5*	*33.4*	*49.8*	*13.3*	*2.9*

Note: Estimates in parentheses are standard deviations. The reported estimates are weighted.

Table A2: Health, Health Care and Labor Force Participation Outcomes by BMI Group Among Women 50+

	Underweight BMI <18.5	Normal weight BMI 18.5-24.9	Overweight BMI 25-29.9	Moderately obese BMI 30-34.9	Severely obese BMI 35+
			Health Outcomes, %		
Poor health	54.3	32.4	39.9	52.3	64.0
ADL-disability	16.3	10.1	11.1	17.3	23.3
Diabetes	2.7	6.4	11.1	19.3	28.5
High cholesterol	9.2	18.3	21.7	24.6	25.4
Hypertension	21.7	25.6	39.9	49.9	60.8
Arthritis	18.9	22.4	27.9	34.9	39.7
Heart disease	14.5	8.3	9.3	12.9	14.2
Depression	46.6	32.6	34.6	39.9	49.7
			Health Care Outcomes (number per annum)		
Doctor visits	6.9 (8.8)	7.5 (11.7)	8.5 (10.9)	9.8 (11.9)	10.3 (12.5)
Hospital nights	19.8 (25.6)	12.7 (21.4)	11.4 (17.7)	14.8 (20.1)	14.2 (19.5)
			Labor Force Participation Outcomes, %		
Retired	54.4	44.9	46.4	47.4	42.4
Employed/self-employed	13.4	25.0	19.1	14.6	13.9
Disabled	6.2	1.8	2.0	2.7	6.1
Unemployed	2.0	2.5	2.4	4.2	3.2
Homemaker	23.9	25.7	29.9	31.1	34.4
Total	*1.9*	*44.1*	*36.1*	*13.5*	*4.3*

Note: Estimates in parentheses are standard deviations. The reported estimates are weighted.

Table A3: Disease Prevalence by Weight Group, %

BMI group	Poor/Fair Self-Reported Health	ADL-Disability	Diabetes	High blood cholesterol	Hypertension	Arthritis	Heart disease	Depression
Men								
Underweight BMI <18.5	71.6**	44.8**	18.0	8.5	20.7	26.5	22.5	63.3**
Normal weight BMI: 18.5-25	28.6	8.4	6.7	15.6	22.3	13.1	12.1	17.2
Overweight BMI: 25-30	29.6	8.6	11.1**	21.1**	32.9**	14.9	13.0	16.8
Moderate obesity BMI: 30-35	42.2**	11.5*	20.0**	21.9**	42.0**	18.6**	18.0**	19.8
Severe obesity BMI: 35+	49.7**	15.1*	26.9**	22.2*	45.1**	16.3	15.1	25.2*
All sample	*31.7*	*9.3*	*11.3*	*19.4*	*30.9*	*14.9*	*13.5*	*17.8*
Women								
	Poor/Fair Self-Reported Health	**ADL-Disability**	**Diabetes**	**High blood cholesterol**	**Hypertension**	**Arthritis**	**Heart disease**	**Depression**
Underweight BMI <18.5	54.4**	16.3	2.7*	9.2**	21.7	18.9	14.5	46.6*
Normal weight BMI: 18.5-25	32.4	10.1	6.4	18.3	25.6	22.4	8.3	32.6
Overweight BMI: 25-30	40.0**	11.1	11.1**	21.7**	40.0**	27.9**	9.3	34.6
Moderate obesity BMI: 30-35	52.3**	17.3**	19.3**	24.6**	50.0**	34.9**	12.9**	39.9**
Severe obesity BMI: 35+	64.0**	23.3**	28.5**	25.4*	60.8**	39.7**	14.2**	49.7**
All sample	*39.6*	*12.1*	*10.7*	*20.5*	*35.5*	*26.8*	*9.6*	*35.4*

Note: Data are presented as percentages. The reported estimates are weighted.

* Significantly different from the normal weight group at the 5% level.
** Significantly different from the normal weight group at the 1% level.

Table A4: Robustness of Obesity Estimated Effects to the Inclusion of Physical Activity in the Model

Model predictions of health and employment outcomes

	Not adjusted for physical activity				Adjusted for vigorous physical activity				Adjusted for vigorous & moderate physical activity			
	Normal weight	Overweight	Moderately obese	Severely obese	Normal weight	Overweight	Moderately obese	Severely obese	Normal weight	Overweight	Moderately obese	Severely obese
	Men				Men				Men			
Poor/fair self-reported health, %	30.2	30.1	39.9**	49.6**	30.9	30.3	39.4**	48.4**	31.1	30.4	39.3**	47.7**
ADL disability, %	7.9	8.4	12.4**	18.7**	8.2	8.5	12.1**	17.9**	8.3	8.6	11.9**	16.9**
Number of doctor visits	6.3	6.5	7.5**	9.4**	6.3	6.6	7.4**	9.3**	6.4	6.6	7.4*	9.2**
Diabetes, %	7.5	11.2**	17.9**	24.8**	7.6	11.2*	17.9**	24.5**	7.6	11.2*	17.8**	24.3**
Hypertension, %	22	31.9**	43.1**	51.5**	22.2	32.0**	42.9**	51.2**	22.2	32.0**	42.9**	51.1**
Heart disease, %	12.5	13.7	17.8**	17.7*	12.6	13.7	17.6**	17.3*	12.6	13.8	17.6**	17.1*
Employed, %	34.2	34.4	32.2*^	28.6**	33.7	34.4	32.5	29.2*	33.7	34.5	32.5	28.9*
	Women				Women				Women			
Poor/fair self-reported health, %	33.8	38.8**	50.4**	63.9**	34.3	38.7**	50.0**	62.7**	34.6	38.9**	48.9**	60.9**
ADL disability, %	9.9	12.3**	17.3**	27.3**	10.8	12.2*	17.0**	26.4**	10.3	12.3*	15.9**	23.9**
Number of doctor visits	7.8	8.2*^	9.4**	10.4**	7.9	8.2	9.4**	10.3**	7.9	8.3	9.2**	10.0**
Diabetes, %	6.2	11.0**	18.5**	27.1**	6.2	11.0**	18.4**	26.7**	6.2	11.1**	18.1**	26.0**
Hypertension, %	27.2	39.8**	48.9**	61.4**	27.3	39.7**	48.9**	61.2**	27.3	39.7**	48.8**	61.1**
Heart disease, %	8.2	9.8**	13.1**	14.7**	8.3	9.8**	13.0**	14.4**	8.4	9.8**	12.8**	13.9**
Employed, %	21.9	20**	18.0**	16.9**	21.8	20.1**	18.1**	17.3**	21.7	20.1**	18.1**	17.4**

Note: ** Significantly different from normal weight at 1% level; * at 5%; *^ at 10%.

Table A5: Cross-Country Effects of Obesity on Health, Utilization of Medical Care and Employment Among Men Aged 50+

Results from by-country analyses: adjusted odds ratio for obesity groups

	Poor self-reported health		ADL-disability		Diabetes		Number of medical visits		Employment/self-employment	
	BMI 30-35	BMI 35+	BMI 30-35	BMI 35+	BMI 30-35	BMI 35+	BMI 30-35	BMI 35+	BMI 30-35	BMI 35+
Austria	1.79* (0.45)	1.90 (0.83)	1.48 (0.61)	2.89 (1.79)	3.10** (1.11)	5.47** (2.94)	1.15 (1.00)	6.22** (1.81)	0.57 (0.22)	0.63 (0.39)
Germany	1.58* (0.30)	3.10** (1.10)	0.88 (0.29)	2.05 (1.04)	3.61** (0.95)	5.76** (2.29)	2.32** (0.88)	5.98** (1.67)	0.56* (0.16)	0.58 (0.29)
Sweden	1.21 (0.39)	4.08** (1.86)	2.90** (0.99)	4.09** (2.23)	4.27** (1.24)	3.59* (1.83)	0.87* (0.39)	1.94* (0.77)	0.83 (0.25)	0.44 (0.24)
Netherlands	1.79** (0.38)	2.29*^ (1.01)	1.36 (0.54)	0.86 (0.91)	1.52 (0.53)	8.04** (3.93)	0.68 (0.80)	1.49 (1.71)	1.06 (0.31)	0.61 (0.34)
Spain	1.69* (0.37)	1.62 (0.63)	1.11 (0.36)	0.23 (0.24)	1.57 (0.47)	3.67 (1.63)	0.14 (1.29)	0.72 (2.32)	0.82 (0.27)	0.49 (0.25)
Italy	1.49*^ (0.33)	3.05** (1.17)	1.92*^ (0.70)	6.01** (3.03)	2.41** (0.70)	1.74 (0.92)	2.57* (1.19)	4.42* (2.12)	0.94 (0.29)	0.75 (0.41)
France	2.26** (0.61)	2.84* (1.47)	2.82** (1.06)	6.07** (3.88)	3.91** (1.59)	10.17** (6.50)	2.07* (1.02)	2.07 (2.03)	0.69 (0.29)	0.64 (0.56)
Denmark	2.03* (0.59)	3.85* (2.14)	1.93 (0.83)	10.35** (6.34)	3.22** (1.42)	4.14*^ (3.09)	1.27 (0.94)	3.31 (1.94)	1.47 (0.53)	1.92 (1.26)
Greece	0.91 (0.25)	1.35 (0.76)	2.43* (1.05)	4.42* (3.28)	2.30* (0.89)	2.65 (1.88)	-0.27 (0.72)	3.18* (1.50)	1.29 (0.44)	0.44 (0.28)
Switzerland	2.02 (0.98)	4.46*^ (3.73)	1.99 (1.44)	6.64*^ (6.79)	3.36* (1.94)	1.98 (2.38)	0.27 (1.08)	-0.44 (2.41)	0.44 (0.22)	0.36 (0.36)
All sample	1.61** (0.11)	2.49** (0.29)	1.69** (0.23)	2.91** (0.87)	2.74** (0.37)	4.19** (0.64)	1.22** (0.33)	3.14** (0.72)	0.82*^ (0.09)	0.60** (0.08)

Note: ** Significantly different from normal weight in the country at 1% level; * at 5%; *^ at 10%. Standard errors are in parentheses.

Table A6: Cross-Country Effects of Obesity on Health, Health Care and Employment Outcomes Among Women Aged 50+

Results from by-country analyses: adjusted odds ratio for obesity groups

	Poor self-reported health		ADL-disability		Diabetes		Number of medical visits		Employment/self-employment	
	BMI 30-35	**BMI 35+**	**BMI 30-35**	**BMI 35+**	**BMI 30-35**	**BMI 35+**	**BMI 30-35**	**BMI 35+**	**BMI 30-35**	**BMI 35+**
Austria	2.16**	5.34**	2.08	3.68**	3.58**	5.19**	0.11	3.54*	0.65	0.70
	(0.44)	(1.91)	(0.59)	(1.71)	(1.15)	(2.47)	(0.93)	(1.69)	(0.22)	(0.39)
Germany	2.87**	7.37**	2.11**	4.79**	4.45**	7.15**	2.51**	2.34*^	0.62*^	0.40**
	(0.52)	(2.24)	(0.59)	(1.76)	(1.08)	(2.39)	(0.89)	(1.39)	(0.16)	(0.16)
Sweden	3.12**	5.45**	1.81*^	3.46*	4.36**	6.32**	1.08**	1.31*^	0.57*	0.41*^
	(0.69)	(2.06)	(0.56)	(1.74)	(1.36)	(3.04)	(0.39)	(0.77)	(0.45)	(0.83)
Netherlands	2.01**	2.71**	1.84*^	4.74**	3.60**	7.66**	1.06*^	3.76**	0.36**	0.44**
	(0.38)	(0.76)	(0.59)	(1.86)	(1.06)	(2.76)	(0.57)	(0.89)	(0.09)	(0.18)
Spain	1.89**	2.99**	2.47**	4.07**	2.19**	3.52**	2.62*	3.59*	0.78	0.57
	(0.34)	(0.77)	(0.66)	(1.36)	(0.56)	(1.09)	(1.09)	(1.51)	(0.23)	(0.23)
Italy	2.02**	3.58**	1.68*^	4.61**	4.11**	5.36**	3.14**	2.35	0.73	0.82
	(0.36)	(1.10)	(0.46)	(1.69)	(1.09)	(2.01)	(1.14)	(1.89)	(0.26)	(0.46)
France	1.93**	6.36**	2.91**	5.53**	6.71**	16.63**	0.34	3.69**	0.36**	0.22**
	(0.46)	(2.49)	(0.99)	(2.64)	(2.59)	(7.83)	(0.85)	(1.34)	(0.12)	(0.13)
Denmark	1.69*	5.01**	2.66*	4.30*	3.31**	4.92**	1.98*	2.52	1.04	1.10
	(0.46)	(2.27)	(1.03)	(2.61)	(1.34)	(3.05)	(0.99)	(1.80)	(0.37)	(0.70)
Greece	2.49**	4.93**	1.34	7.14**	2.82**	8.40**	0.28	0.91	1.28	0.66
	(0.54)	(1.71)	(0.47)	(3.12)	(1.11)	(3.95)	(0.79)	(1.28)	(0.39)	(0.37)
Switzerland	1.95	3.77*	3.88*		4.82*	10.72*	0.96	0.17	1.27	5.02*^
	(0.79)	(2.56)	(2.04)		(3.14)	(10.26)	(1.25)	(2.23)	(0.60)	(4.32)
All sample	2.19**	4.09	2.09**	4.20**	3.58**	6.02**	1.59**	2.57**	0.65**	0.55**
	(0.12)	(0.50)	(0.13)	(0.28)	(0.34)	(0.77)	(0.38)	(0.39)	(0.08)	(0.09)

Note: ** Significantly different from normal weight in the country at 1% level; * at 5%; *^ at 10%. Standard errors are in parentheses.

Table A7: Differences in Effects of Obesity on Health, Utilization of Medical Care and Employment Outcomes Between Countries with High and Low Prevalence of Obesity

	Men in countries with relatively low obesity rates						
	Normal weight	**Overweight**	**Moderately obese**	**Severely obese**	**Increase in % points for overweight**	**Increase in % points for moderately obese**	**Increase in % points for severely obese**
Poor/fair self-reported health	24.4	24.4	35.2	47.1	0.0	10.8	22.7
ADL-disability	8.5	9.9	15.5	25.1	1.4	7.0	16.6
Diabetes	6.1	10.8	16.2	24	4.7	10.1	17.9
Heart disease	14.1	15.6	20.7	18.9	1.5	6.6	4.8
Depression	18.5	18.3	18.6	31.2	-0.2	0.1	12.7
Doctor visits	5.2	5.5	6.3	6.9	0.3	1.1	1.7
Hospital nights	2.7	2.4	3	2.6	-0.3	0.3	-0.1
Retired	55.7	56.1	53.7	54.4	0.4	-2.0	-1.3
Employment	37.1	36.3	36.2	33	-0.8	-0.9	-4.1
	Men in countries with relatively high obesity rates						
	Normal weight	**Overweight**	**Moderately obese**	**Severely obese**	**Increase in % points for overweight**	**Increase in % points for moderately obese**	**Increase in % points for severely obese**
Poor/fair self-reported health	32.9	32.6	41.5	49.9	-0.3	8.6	17.0
ADL-disability	8.1	7.6	10.6	15.5	-0.5	2.5	7.4
Diabetes	8.5	11	18.3	24.8	2.5	9.8	16.3
Heart disease	11.8	12.8	16.2	17.1	1.0	4.4	5.3
Depression	19.2	16.2	20.5	21.7	-3.0	1.3	2.5
Doctor visits	6.7	7	8	10.8	0.3	1.3	4.1
Hospital nights	2.6	1.9	2.4	4.3	-0.7	-0.2	1.7
Retired	58.5	59.1	61.2	60.8	0.6	2.7	2.3
Employment	32.5	34.2	30.1	26.6	1.7	-2.4	-5.9

Women in countries with relatively low obesity rates

	Normal weight	Overweight	Moderately obese	Severely obese	Increase in % points for overweight	Increase in % points for moderately obese	Increase in % points for severely obese
Poor/fair self-reported health	25.4	29.5	40.7	54	4.1	15.3	28.6
ADL-disability	8.8	11.9	16.3	23.9	3.1	7.5	15.1
Diabetes	4.3	8.5	15.4	25.6	4.2	11.1	21.3
Heart disease	8.2	10.2	13	19.3	2.0	4.8	11.1
Depression	32.9	35.9	38.3	51	3.0	5.4	18.1
Doctor visits	6.1	6.4	7.2	8.8	0.3	1.1	2.7
Hospital nights	1.4	1.5	2.2	3.2	0.1	0.8	1.8
Retired	46.8	48.8	47.5	52.6	2.0	0.7	5.8
Employment	28.3	26.2	22.1	23	-2.1	-6.2	-5.3

Women in countries with relatively high obesity rates

	Normal weight	Overweight	Moderately obese	Severely obese	Increase in % points for overweight	Increase in % points for moderately obese	Increase in % points for severely obese
Poor/fair self-reported health	37.5	43	54.3	68.2	5.5	16.8	30.7
ADL-disability	10.6	12.3	17.5	29.1	1.7	6.9	18.5
Diabetes	7.2	12.1	19.5	27.3	4.9	12.3	20.1
Heart disease	8.3	9.6	13.2	12.1	1.3	4.9	3.8
Depression	33.8	34.2	40.9	47.7	0.4	7.1	13.9
Doctor visits	8.6	9.2	10.5	11.1	0.6	1.9	2.5
Hospital nights	2.1	2.4	3.4	4.4	0.3	1.3	2.3
Retired	45.3	46.2	48.2	48.4	0.9	2.9	3.1
Employment	19.1	17.3	16.7	14.2	-1.8	-2.4	-4.9

Note: Model predictions of outcomes by BMI group.

Table A8: Differences in Effects of Obesity on Health Outcomes Across SES Groups

Percentage increase in predicted condition prevalence by BMI across SES groups, %

	Poor/fair SRH			ADL-disability			Diabetes		
Group	**Overweight**	**Moderately obese**	**Severely obese**	**Overweight**	**Moderately obese**	**Severely obese**	**Overweight**	**Moderately obese**	**Severely obese**
					Men				
Primary or no education	-1.0	7.5**	18.0**	0.7	6.4**	13.4**	5.3**	10.6**	19.1**
Secondary education	-1.9	10.7**	19.9**	-0.4	2.4	8.0**	3.0**	12.3**	16.5**
Tertiary education	2.4	11.8**	24.8**	0.7	2.0	11.3*	0.9	6.9**	16.3**
Lowest income quartile	-1.5	13.5**	16.4**	0.3	8.2**	8.7*	3.3*^	9.6**	12.8**
Highest income quartile	1.3	9.2**	25.0**	-0.4	2.7	5.2	3.6**	11.2**	17.4**
					Women				
Primary or no education	2.6*	14.4**	28.8**	1.8*^	8.1**	19.2**	4.8**	11.2**	23.2**
Secondary education	7.8**	21.3**	31.9**	2.8**	6.3**	11.4**	5.5**	17.6**	15.6**
Tertiary education	6.7**	14.9**	27.4**	2.2*	4.4*	20**	3.1**	8.6**	20.9**
Lowest income quartile	4.3*	12.9**	24.6**	3.6*	7.7**	19.7**	7.6**	12.4**	29.0**
Highest income quartile	5.4**	15.3**	34.2**	1.4	5.9**	14.4**	3.4**	9.8**	9.2**

Note: ** Significantly different from normal weight in the country at 1% level; * at 5%; *^ at 10%.

Table A9: Decomposition of Health: Contribution to Disease Prevalence by Different Risk Factors

	Men								
	Poor/fair self-reported health					ADL-disability			
	Factor prevalence, %	Effect of factor on poor self-reported health, % change	Total effect, %	Poor self-reported health prevalence, %	Factor share in poor self-reported health prevalence, %	Effect of factor on ADL-disability, % change	Total effect, %	ADL-disability prevalence, %	Factor share in ADL-disability prevalence
Current smoking	24	3	0.8	31.7	2	1	0.3	9.3	3
Past smoking	40	4	1.7	31.7	5	2	0.8	9.3	8
Drinking	26	-3	-0.7	31.7	-2	0	0.1	9.3	1
10 years aging	16	10	1.6	31.7	5	1	0.2	9.3	2
20 years aging	12	12	1.4	31.7	5	4	0.5	9.3	5
30 years aging	6	26	1.4	31.7	5	15	0.9	9.3	9
Obesity	16	11	1.9	31.7	6	5	0.9	9.3	10
	Women								
	Poor/fair self-reported health					**ADL-disability**			
	Factor prevalence, %	Effect of factor on poor self-reported health, % change	Total effect, %	Poor self-reported health prevalence, %	Factor share in poor self-reported health prevalence, %	Effect of factor on ADL-disability, % change	Total effect, %	ADL-disability prevalence, %	Factor share in ADL-disability prevalence
Current smoking	13	5	0.7	39.6	2	2	0.2	12.1	2
Past smoking	14	-1	-0.1	39.6	0	0	0.1	12.1	1
Drinking	7	-7	-0.5	39.6	-1	0	0.0	12.1	0
10 years aging	15	7	1.1	39.6	3	2	0.4	12.1	3
20 years aging	13	17	2.3	39.6	6	9	1.2	12.1	10
30 years aging	9	29	2.6	39.6	6	18	1.6	12.1	13
Obesity	18	20	3.6	39.6	9	10	1.7	12.1	14

*Not*e: Based on methodology in Kapteyn, Smith, van Soest, 2004. Self-Reported Work Disability in the US and The Netherlands. RAND Working Paper: p.7-10.

Table A10: Obesity-Health Gradient and Selected Characteristics of Health Care Systems and Populations by Country

Table ranked by obesity-related effects on poor self-reported health among women

	% difference in rate of poor self-reported health (SRH) between normal weight and obese women	% difference in diabetes rate between normal weight and obese women	Prevalence of obesity among population 50+, %, 2004	% of out of pocket health costs in total health expenditure, 2001	Total health expenditure per capita, USD PPP, 2004	% satisfied with health care system, 2001	Practicing physicians, per 1000 population, 2003	Healthy life expectancy at age 60, years, 2001	GDP per capita, USD PPP 2004	% of adult population daily smokers, 2004	Daily calories per capita, 2000
Switzerland	12	10	12	33	4077	n.a.	3.6	16.9	33,678	26.8	3293
Denmark	14	9	13	16	2881	76	2.9	15.5	31,332	26.0	3396
Netherlands	16	14	16	9	3041	73	3.1	15.0	31,191	30.0	3294
Sweden	17	12	14	15	2825	59	3.3	16.5	30,361	16.2	3109
Spain	17	11	26	24	2094	48	3.2	15.2	25,582	28.1	3353
Italy	18	16	17	23	2392	26	4.1	15.5	27,699	24.2	3661
Austria	18	12	20	19	3124	83	3.4	15.7	31,944	29.3	3757
France	20	20	15	10	3159	78	3.4	16.1	29,554	23.0	3591
Greece	21	9	22	45	2162	19	4.4	15.7	21,689	38.6	3705
Germany	26	19	17	11	3005	50	3.4	15.0	28,065	24.3	3451
Correlation with % diff. in poor SRH by obesity		0.62	0.37	-0.14	-0.36	-0.36	0.30	-0.46	0.07	0.40	-0.56
Correlation with % diff in diabetes by obesity		1.00	-0.13	-0.62	0.10	0.13	-0.03	-0.24	-0.41	0.18	0.04

Source: OECD Factbook 2006: Economic, Environmental and Social Statistics. OECD Health Data 2003. Prevalence of obesity and estimates of obesity effects are from SHARE, 2004. System satisfaction: Blendon R, Kim M, Benson J, The public versus the WHO on health system performance, *Health Affairs*, vol. 20(3), 2001.
Note: Neither of pairwise correlation coefficients significant at 5% level.

Table A11: Physical Activity Rates by Country, %

	No physical activity		More than weekly vigorous and moderate physical activity	
	Men	**Women**	**Men**	**Women**
Austria	8.3	14.0	29.8	18.9
Denmark	6.3	7.9	48.7	38.8
France	10.0	15.6	28.7	18.3
Germany	5.5	10.7	37.6	31.2
Greece	6.5	8.4	29.7	25.0
Italy	16.0	25.3	25.7	18.1
Netherlands	5.6	10.2	39.8	35.7
Spain	12.0	15.0	31.5	20.2
Sweden	4.8	7.5	43.6	31.3
Switzerland	2.8	4.5	39.4	31.0
All SHARE	9.4	14.9	32.8	24.4

Note: Data weighted to be nationally representative.

Table A12: Percentage of People Reporting Any Expenditure on Food Consumed Outside Home by Obesity Status and Country, %

	Non-obese	**Obese**
Austria	69	66
Germany	71	61**
Sweden	70	69
Netherlands	59	53*
Spain	38	31*
Italy	50	32**
France	54	46*^
Denmark	48	49
Greece	56	47**
Switzerland	86	88
All SHARE	58	47**

Note: Data weighted to be nationally representative.

** Significantly different from the non-obese group at the 1% level, *at 5%, *^ at 10%.

Table A13: Food Availability Over Time and Countries, Average of Cal/Capita/Day

Countries Ranked by Lowest Amount of Food Available for Human Consumption in Each Period

1961		1980		1990		2000	
Spain	2632	Sweden	2992	Sweden	2975	Sweden	3089
Greece	2820	Spain	3063	Denmark	3168	Spain	3370
Sweden	2836	Netherlands	3071	Spain	3247	Netherlands	3374
US	2882	Denmark	3127	Netherlands	3289	Denmark	3390
Germany	2889	US	3155	Germany	3310	Germany	3433
Italy	2914	Greece	3216	Switzerland	3346	Switzerland	3441
Netherlands	3057	Germany	3340	US	3472	France	3601
Denmark	3187	Austria	3354	Austria	3485	Greece	3648
Austria	3190	France	3376	France	3512	Italy	3701
France	3194	Switzerland	3491	Greece	3524	Austria	3761
Switzerland	3521	Italy	3590	Italy	3591	US	3814

Source: FAO Statistics division.

Table A14: Phases of Per Capita Real GDP Growth

	Annual average compound rate of growth, %		
	1913-50	1950-73	1973-92
Austria	0.2	4.9	2.2
Denmark	1.6	3.1	1.6
France	1.1	4	1.7
Germany	0.3	5	2.1
Greece	0.5	6.2	1.5
Italy	0.8	5	2.4
Netherlands	1.1	3.4	1.4
Spain	0.2	5.8	1.9
Sweden	2.1	3.1	1.2
Switzerland	2.1	3.1	0.8
US	1.6	2.4	1.2

Source: Maddison A. "Monitoring the global economy: 1820-1992", OECD 2001.

Table A15: Obesity-Risk Factors Gradient and Selected Characteristics of Populations Across SHARE Countries

Country	% change in obesity rates by physical activity in men	% change in obesity rates by education in men	% change in obesity rates by income in men	Prevalence of physical inactivity, %	Prevalence of low education, %	Prevalence of current smoking, %	% of out of pocket expenditure in total health care costs, 2001	Total health expenditure per capita, USD PPP, 2004	Daily calories per capita, 2002	GDP per capita, USD PPP 2004
Austria	0	3	3	8	18	25	19	3124	3673	31944
Denmark	2	6	4	6	15	33	16	2881	3439	31332
France	4	4	7	10	48	19	10	3159	3654	29554
Germany	3	10	4	6	7	25	11	3005	3496	28065
Greece	3	8	1	6	58	33	45	2162	3721	21689
Italy	1	8	1	16	69	25	23	2392	3671	27699
Netherlands	8	7	-1	6	49	28	9	3041	3362	31191
Spain	0	11	1	12	80	29	24	2094	3371	25582
Sweden	3	2	2	5	53	14	15	2825	3185	30361
Switzerland	13	3	8	3	45	21	33	4077	3526	33678
Correlation with effect of physical inactivity on obesity		-0.34	0.42	-0.62	-0.01	-0.23	0.12	0.76*	-0.12	0.47
Correlation with effect of low education on obesity			-0.47	0.41	0.21	0.62	0.10	-0.64*	0.07	-0.67*
Correlation with effect of low income on obesity				-0.31	-0.37	-0.41	-0.01	0.73*	0.23	0.46

Source: OECD Factbook 2006: Economic, Environmental and Social Statistics. OECD Health Data 2003.
Prevalence of behavioral risk factors and estimated effects are from SHARE, 2004.

* Significant at 5% level.