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Greenhouse gas benefits of fighting obesity

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Greenhouse gas benefits of fighting obesity

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Abstract: Obesity has become a serious public health problem in both industrialized and rapidly industrializing countries. It increases greenhouse gas emissions through higher fuel needs for transportation of heavier people, lifecycle emissions from additional food production and methane emissions from higher amounts of organic waste. A reduction of average weight by 5 kg could reduce OECD transport CO_2 emissions by more than 10 million t, while a reduction of consumption of energy-rich food to 1990 levels would lead to life-cycle emissions savings of more than 100 million t CO_2 equivalent and by more than 2 million t through reduction of associated food waste. Due to the intimate behavioural nature of the obesity problem, policies to reduce obesity such as food taxation, subsidization of human-powered transport, incentives to reduce sedentary leisure and regulation of fat in foodstuffs have not yet been implemented to any extent. The emissions benefits of fiscal and regulatory measures to reduce obesity could accelerate the tipping point where a majority of voters feels that the problem warrants policy action.

Key words: public health, food production, transport, waste management, greenhouse gas emissions

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1 Obesity as major public health problem

In the last 20 years, obesity has become a serious public health problem (WHO 2000). Obese individuals tend to suffer from secondary diseases such as diabetes, hypertension and heart disease. Obesity strikes not only advanced industrialised countries but also the developing world. So far, all attempts to stop its increase have been unsuccessful and the costs of obesity-related diseases weigh on the health systems. We want to assess the impacts of obesity increase on greenhouse gas emissions and discuss synergies between public health and climate policy.

1.1 Definitions

An individual is officially defined as obese if his body mass index (BMI, weight divided by the square of height) is above 30. Many medical experts see obesity already starting at a BMI of 25 which is officially defined as “overweight” (WHO 2000, p. 9).

1.2 Prevalence of obesity

Average daily food intake per person in industrialised countries has increased from 12.34 MJ[1] in the mid-1960s to 14.15 MJ in the late 1990s (WHO 2003, p. 15). Around the turn of the century, obesity in OECD countries varied between 3.2% (Japan and Korea) and 30.9% (USA) of the adult population. From the early 1980s the increase ranged from one percentage point (Japan) to 16 points (USA) (OECD 2003, p.75). In some medium income countries, obesity reaches surprisingly high levels (Egypt 22%, South Africa 16%). Decadal increases in these countries reached 3-5 percentage points (Popkin and Gordon-Larsen 2004, p. S6). In some societies such as the tropical Pacific islands, extremely high obesity rates of more than 50% exist; they may be due both to genetic susceptibility and cultural values (Collins et al. 1990, WHO 2000, p. 29). Obesity is mainly caused by high-fat food intake, increased frequency of food intake and lack of physical activity (FAO 2001).

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[1] SI units are used in this paper; 4.1868 J = 1 cal.

1.3 Economic and social consequences of obesity

Obesity causes direct and indirect economic (WHO 2000, p. 78) and social costs. Direct costs relate to health bills. Costs of secondary diseases caused by obesity reach around 100 billion $ in the USA, i.e. 6% of the national health-related expenditures (Wolf and Colditz 1998). Similar studies done in the early 1990s in Australia, France, Netherlands and Sweden calculate costs of 2-5% of health expenditures (Lévy et al. 1995). Cutler et al. (2003, p. 94) estimate 40-100 billion $ annual spending on weight loss products in the U.S. Schubert (2005) estimates venture capital investment in pharmaceutical research targeting obesity at 300 million $ in 2004 and 2005.

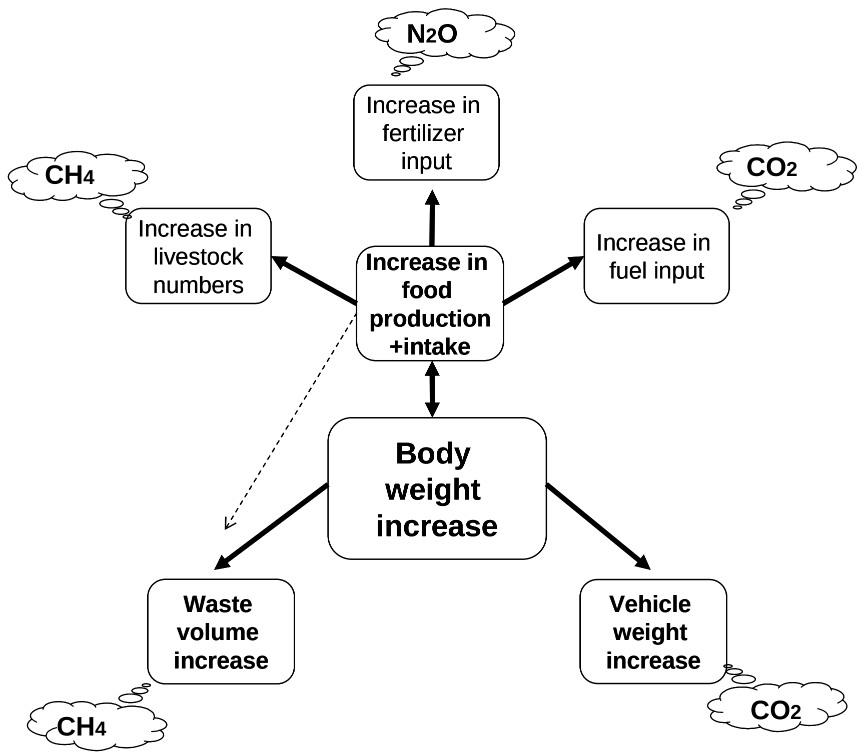
Indirect costs are found for example in transport. According to Dannenberg et al. (2004), the increase of the average weight of US citizen by 4.5 kg during the 1990s and the corresponding change in the air traffic regulation cost airlines 275 million $ at fuel prices of 2000. Another category of indirect costs are productivity losses of obese individuals, of which there is "quite strong evidence", particularly for women but no reliable numbers (Wolf 1998, p. 61S). Social costs arise due to the ostracism obese people suffer. Obesity has a higher prevalence in low social strata and in an industrialised country context is likely to lead to a lower social status of an individual, particularly women (Gortmaker et al. 1993).

2 The impact of obesity on greenhouse gas emissions

Obesity has several direct and indirect impacts on greenhouse gas emissions. We focus on the growth of emissions in the transport sector due to the increased weight of passengers as well as emissions increases due to increased food production and a higher degree of food processing during the food production chain. Moreover, the increase in organic waste and related methane emissions are assessed. Other important aspects as the increase of transportation of food products and further indirect effects on greenhouse gas emissions like packaging and inorganic waste production will not be regarded.

Figure 1 looks at the emissions impacts of the increase of body weight, which is due to an increase of food intake. Emissions of the transport sector rise due to increased fuel use and of organic waste due to increased digestion of food and the resulting waste products. To satisfy the increased food demand, food production rises which in turn influences several factors as fuel use, fertilizer use and production as well as livestock numbers.

Figure 1: The greenhouse gas emissions impacts of an increase in human body weight



2.1 Transport sector: increasing emissions due to vehicle weight

Moving heavier people around will lead to higher energy use of transportation. According to Cutler an extra intake of 500 kJ per day over a period of 20 years leads to a 5 kg average weight increase (Cutler 2003, p. 100). An increase of the average body weight by 5 kg will have a different impact according to the weight of the vehicle. The relationship between weight of passengers and weight of the vehicle often depends on the number of passengers a vehicle can accommodate (see table 1).

Table 1: Impacts of weight increases on fuel use and greenhouse gas emissions of different vehicle types

Vehicle	Passengers	Vehicle weight per passenger (kg)	Weight increase (kg per vehicle)	Weight increase in %	Increase in fuel use (l per pkm)	Emissions increase (g CO_2/pkm)
Car	1.3	1388	6.5	0.36	0.00029	0.67
Plane	250	960	1250	0.52	0.00022	0.57
Rail	500	1080	2500	0.46	0.00057	0.35

For the calculation an initial average weight of 80 kg per passenger is assumed. The assumed average weight of cars is based on statistics of the German Federal Bureau of Motor Vehicles and Drivers (Kraftfahrtbundesamt 2006). The average weight of a train is estimated as 500t with an average occupancy of 500 passengers (Deutsche Bahn 2004, IFEU Institut 2002); the average fuel consumption of airplanes is based on data of Lufthansa (Lufthansa 2005) and TREMOD[2]. Average passenger number (250) and weight (220 tons) data is based on a survey of the aircraft families Boeing 737, 747, 757, 767, Airbus A310, A320 and A340. According to the German Federal Environmental Agency (Umweltbundesamt 2001) these aircraft types amount over 90 percent of the transcontinental air traffic. Dannenberg et al. (2004) calculate that the increase of the average weight of US citizen by 4.5 kg during the 1990s and the corresponding change in US air traffic regulation led to an increase of fuel use by 2.4% and of annual CO_2 emissions from US air traffic by 3.8 million t[3]. We did not find any impact of weight increase of passengers on passenger ships. The shipping companies TT-Line, Scandlines, Stena-Line, Colorline, Moby-Line, AIDA and Superfast clearly stated that the increase of passenger weight has no significant effect on the fuel usage of the vessels, which is rather determined by the factors wind, waves and current.

Subsequently the impacts on fuel use and CO_2 emissions are extrapolated with traffic data for Germany, the EU25 and the OECD. Table 2 thus shows that an average 5 kg weight increase would result in additional 0.7 million t of CO_2 emissions for Germany (EU25: 3.4 million t; OECD: 10.2 million t)

[2] TREMOD is an expert Transport Emission Estimation Model run by the German Federal Environment Agency.

[3] Due to indirect impacts of contrails and NO_x, the greenhouse impact of air traffic is at least twice as high as the CO_2 emissions suggest

Table 2: Effects of an average 5kg weight increase on traffic sector for different areas

		Total traffic (billion pkm)	Shares of the traffic sectors in % of total traffic	Increase in fuel use (units per pkm)**	Total increase in fuel use (million units)**	Increase of g CO_2 per pkm	Total CO_2 increase due to an average 5 kg weight increase (1000 t)
Germany	Car*	907	74	0.00029	261.4	0.67	603.9
	Plane	48.4	4	0.00022	10.8	0.57	27.8
	Rail	72.6	6	0.00057	41.5	0.35	25.7
	Total	**1028**	**84**	**-**	**-**	**-**	**657.4**
EU 25	Car*	4586	77	0.00029	1321.9	0.67	3053.6
	Plane	449	8	0.00022	100.3	0.57	257.8
	Rail	345	6	0.00057	197.1	0.35	122.2
	Total	**5380**	**90**	**-**	**-**	**-**	**3433.6**
OECD	Car*	13071	82	0.00029	3767.7	0.67	8703.4
	Plane***	2087.5	13	0.00022	459.3	0.57	1189.9
	Rail	791.6	5	0.00057	452.2	0.35	280.4
	Total	**15950.1**	**100**	**-**	**-**	**-**	**10173.6**

Data for Germany (2004), Source: Bundesministerium für Verkehr-, Bau- und Wohnungswesen 2005, data for EU25 (2003), Source: EU 2005, data for OECD countries (2003), Source: OECD 2005, data for air traffic in OECD (2002): IATA 2005
* motorised individual traffic,
** expressed in litres of fuel for car and planes, in kWh for rail
*** All national and international flights operated by OECD-based airlines

According to table 3, the economic costs of an average 5 kg weight gain amount for 0.4 billion Euro for Germany (EU25: 1.9 billion Euro; OECD: 5.4 billion Euro). While the magnitude of transport-related greenhouse gas emissions from obesity is not comparable with energy policy as such, these emissions are significant and warrant policy intervention.

Table 3: Economic costs of an average 5 kg weight increase

		Increase of fuel cost (million €)	Increase of CO_2 cost (million €)	Total increase of cost (million €)
Germany	Car*	347.7	9.1	
	Plane	4.8	0.4	
	Rail	3.8	0.4	
	Total	**356.3**	**9.9**	**366.2**
EU25	Car*	1758.1	45.8	
	Plane	44.1	3.9	
	Rail	18.2	1.8	
	Total	**1820.5**	**51.5**	**1872.0**
OECD	Car*	5011.0	130.6	
	Plane	202.1	17.8	
	Rail	41.7	4.2	
	Total	**5254.8**	**152.6**	**5407.4**

Price for 1 unit of fuel (€): Car: 1.33 (1l of Gasoline), Plane: 0.44 (1l of Jet Kerosene), Rail: 0.0922 (1kWh)
Price for 1 t of CO_2-eq is assumed as 15 € (Price for post-2008 EU allowances at the EEX November 2006),
Source: http://www.mwv.de/Verbraucherpreise_in_EU.html,
http://www.iata.org/whatwedo/economics/fuel_monitor/index.htm,
www.dbenergie.de (all accessed 29.06.2006)

2.2 Food production

This section examines the contribution of obesity-causing food products to global warming. As the nutrition patterns have shifted towards energy-dense food products within the last decades, the impact of this shift on greenhouse gas emissions is assessed. According to the WHO a significant increase in the intake of dietary fats has taken place over the past three decades (Table 4.). As obesity is caused by increase of too high energy intake which mainly comes along with high fat intake and as these fat calories are provided to a large extent by saturated fatty acids, food products containing high amounts of saturated fatty acids will be considered below. In this concern the ratio of dietary fat intake from animal sources is a key factor for the prevalence of obesity as animal originated foods contain high amounts of fatty acids (WHO 2003, p.18ff). Table 5 shows the development of per capita consumption of livestock products over the period from 1964 to 2030. The consumption of meat has increased by 43% from

1964 to 1999 in the industrialised countries. For the same period, the consumption of milk has increased by 14%. We will look at food of high energy density like meat, dairy products, bread and wheat as they are mainly responsible for the weight increase (WHO 2003:70).

Table 4: Trends in the dietary supply of fat

Region	Supply of fat (g per capita per day)				
	1967–1969	1977--1979	1987–1989	1997–1999	Change between 1967–1969 and 1997–1999
World	53	57	67	73	20
North Africa	44	58	65	64	20
Sub-Saharan Africa[a]	41	43	41	45	4
North America	117	125	138	143	26
Latin America and the Caribbean	54	65	73	79	25
China	24	27	48	79	55
East and South-East Asia	28	32	44	52	24
South Asia	29	32	39	45	16
European Community	117	128	143	148	31
Eastern Europe	90	111	116	104	14
Near East	51	62	73	70	19
Oceania	102	102	113	113	11

[a] Excludes South Africa

Source: WHO 2003, p. 18 based on FAO data.

Table 5: Per capita consumption of livestock products

Region	Meat (kg per year)			Milk (kg per year)		
	1964–1966	1997–1999	2030	1964–1966	1997--1999	2030
World	24.2	36.4	45.3	73.9	78.1	89.5
Developing countries	10.2	25.5	36.7	28.0	44.6	65.8
Near East and North Africa	11.9	21.2	35.0	68.6	72.3	89.9
Sub-Saharan Africa[a]	9.9	9.4	13.4	28.5	29.1	33.8
Latin America and the Caribbean	31.7	53.8	76.6	80.1	110.2	139.8
East Asia	8.7	37.7	58.5	3.6	10.0	17.8
South Asia	3.9	5.3	11.7	37.0	67.5	106.9
Industrialized countries	61.5	88.2	100.1	185.5	212.2	221.0
Transition countries	42.5	46.2	60.7	156.6	159.1	178.7

[a] Excludes South Africa.

Source: WHO 2003:121

Table 6 shows the CO_2 emissions of food products of animal origin and of wheat and bakery products, which these products emit during their lifecycle (LCA food database 2003[4]). Values are provided ex slaughterhouse, ex dairy, ex bakery and ex factory as well as ex retail. It becomes clear that meat products have the highest emission factors whereas milk does not play an important role. One can easily see that the emissions depend on the chosen product. Chicken meat does not provide as much emissions as cattle tenderloin or pig meat. Cheaper cattle products like outside meat also emit less CO_2 than other meat products. Milk emits a negative value due to its production chain.

Table 6: Lifecycle CO_2 emissions of food products (g CO_2-eq. per kg of product)

	Meat					**Dairy**		**Bakery**		**Wheat**
	Cattle Tenderloin	Cattle Outside	Fresh chicken	Pork Tenderloin	Ham, Neck, Bacon	Cheese	Full milk	Rolls (fresh)	Wheat bread (fresh)	Wheat flour
Ex slaughterhouse, dairy, bakery, factory	67900	2230	3110	4520	2900	130	-46	880	780	1010
Ex retail	68000	2230	3160	4560	2950	180	-0.09	930	840	1130

(Source: http://www.lcafood.dk, accessed 11.08.2006)

The data is based on input factors like inter alia electricity, fuel and fertilizer (Table 7).

Table 7: Input factors included in LCA values

	Meat				**Dairy**		**Bakery**	**Wheat**
	Cattle Tenderloin	Cattle Outside	Fresh chicken	Pork Tenderloin	Cheese	Full milk	Rolls (fresh)	Wheat flour
Input factors included (inter alia)	Electricity, Fuel, Wheat	Electricity, Fuel, Wheat	Electricity, Fuel, Soy seed, Wheat	Electricity, Fuel, Soy seed, Wheat	Electricity, Fertilizer, Fuel	Electricity	Electricity, Fertilizer, Fuel, Wheat	Electricity, Chemicals inorganic, Fertilizer, Fuel

(Source: http://www.lcafood.dk, accessed 17.08.2006)

[4] This database is the result of the project “Lifecycle Assessment of Basic Food" (2000 to 2003) by the Danish Institute of Agricultural Sciences, Danish Institute for Fisheries Research, Højmarkslaboratoriet, Danish Research Institute of Food Economics, Danish Technological Institute and 2.-0 LCA Consultants. The site is hosted by Danish Institute of Agricultural Sciences and the data relies on the LCA modeling-software SimaPro 6.0, a LCA-tool which calculates environmental impacts from products.

Table 8 lists the food consumption of OECD countries for 2002 for the regarded food products. Applying the lifecycle CO_2 emissions of each food product and extrapolating these with the consumption data gives us the CO_2 emissions due to increase in OECD food consumption (Table 9)

Table 8: 2002 OECD food consumption (in 1000 t per year)

	Bovine meat (incl. cattle)	Chicken meat	Pig meat	Milk, whole, fresh	Wheat
Australia	766.01	649.81	378.26	4,137.42	1,589.43
Austria	152.93	98.4	593.45	2,080.79	590.26
Belgium	202.57	251.23	364.03	2,583.68	1,146.73
Canada	1,023.30	1,001.16	947.52	6,400.29	2,798.87
Czech Republic	91.95	211.25	431.85	1,834.99	1,125.77
Denmark	147.28	89.07	346.33	859.36	552.56
Finland	93.79	79.4	173.98	1,301.18	397.22
France	1,685.61	866.28	2,175.22	15,451.79	6,291.38
Germany	967.68	653.45	4,372.72	19,832.09	7,542.45
Greece	211.51	174.3	358.07	2,168.99	1,515.59
Hungary	56.77	218.84	515.43	1,374.72	1,185.49
Iceland	3.67	4.8	6.02	70.24	35.52
Ireland	105.57	80.86	164.05	976.95	372.48
Italy	1,379.06	690.27	2,463.72	12,896.89	8,619.93
Japan	1,097.91	2,096.27	2,414.72	8,597.16	5,727.19
Korea, Republic of	620.35	473.48	1,150.05	2,081.55	2,381.75
Mexico	1,904.52	2,335.47	1,317.29	11,660.84	3,783.18
Netherlands	329.66	187.31	744.43	3,972.97	930.57
New Zealand	101.52	134.04	75.35	0	338
Norway	92.62	46.2	112.03	1,083.36	469.06
Poland	228.25	737.37	1,844.66	6,109.42	4,189.27
Portugal	163.7	207.05	430.15	2,052.40	1,127.46
Slovakia	46.39	53.32	174.37	779.34	603.83
Spain	643.94	1,215.48	2,660.19	6,638.93	3,622.21
Sweden	191.64	118.36	325.71	2,749.77	858.65
Switzerland	147.94	88.95	250	2,018.52	722.69
Turkey	327.92	676.81	0.02	7,210.85	13,613.59
United Kingdom	1,137.46	1,515.67	1,501.68	13,596.58	5,653.88
United States of America	12,700.65	12,185.14	8,720.62	72,136.55	23,327.91
OECD	**26622.17**	**27140.04**	**35011.92**	**212657.62**	**101112.92**

Source: FAO (2006)

Table 9: Increase of lifecycle CO_2 emissions of OECD food consumption 1990-2002 (million t of CO2-eq.) and their economic cost

	Cattle Tenderloin*	Cattle Outside**	Chicken meat	Pig meat	Milk, whole, fresh	Wheat
Food consumption 2002 (million t)	2.7	23.9	27.1	35.0	212.7	101.1
Food consumption 1990 (million t)	2.4	22.5	17.5	28.8	188.3	86.3
CO_2 emissions of food products ex retail (t CO_2-eq. per t of product)	68.0	2.2	3.2	4.6	0	1.1
2002 CO_2 emissions of food consumption (million t)	183.6	52.6	85.8	159.7	0	114.3
Increase of CO_2 emissions of food consumption (million t)	**20.4**	**3.1**	**30.7**	**28.5**	**0**	**16.3**
Economic cost of CO_2 emissions (million €)* **	306	46.5	460.5	427.5	0	244.3

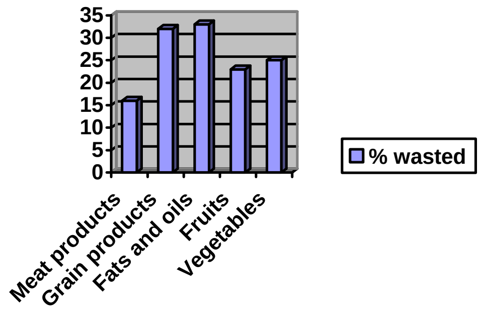
*Assumption: 10% of bovine meat production
** Assumption: 90% of bovine meat production
*** Price for 1 t of CO_2-eq is assumed as 15 € (Price for post-2008 EU allowances at the EEX October 2006)

The increase in consumption of greenhouse-gas intensive food products in the OECD in the 1990s has led to an emissions increase of almost 100 million t CO_2 equivalent which would be valued at 1.5 billion €.

2.3 Waste management

A higher food intake will automatically lead to a higher generation rate of solid and liquid wastes. Food production generates organic waste that will produce methane if decomposing anaerobically. Kantor et al. (1997) estimate that in 1995, 27% of the total food supply available in the U.S. was wasted, a total of 44 million t. The rates for different food types are shown in Figure 2.

Figure 2: Waste generation rates according to food types in the U.S in 1995.



Source: Kantor et al. (1997), p. 7

Extrapolating this result to the entire OECD with data from FAO (2006), the waste generation due to increase in food consumption from 1990 to 2002 can be calculated. The total food waste increment reaches 7.5 million t. According to the Waste Reduction Model by USEPA (2006), one tonne of food waste landfilled generates 0.15 t CO_2 eq. if the landfill collects 75% of the landfill gas and uses it energetically. If the waste is landfilled without methane recovery, emissions are 1.5 t CO_2. Conservatively assuming that 75% of OECD landfills are equipped with methane recovery equipment, the average t of incremental food waste generates 0.35 t CO_2 and total emissions due to food consumption increase reach 2.6 million t CO_2 eq.

3 Policies to fight obesity

According to Williamson et al. (1998, p. 174), there is limited information on effectiveness and efficiency of medical interventions to reduce weight of obese individuals. Wolf (2002) argues that it is highly likely that medical obesity treatment is not cost-effective. Likewise, WHO (2000, p. 156) stresses that it is very difficult to treat obesity once it has developed. However, there is only little information about the effectiveness of obesity prevention strategies. So far, only the government of Singapore has a far-ranging obesity-prevention policy targeting specific groups in its population (WHO 2000, p. 184). The “National Healthy Lifestyle Programme” was introduced in 1992; its initial reason was to improve the fitness of soldiers as the share of obese recruits had doubled within five years in the late 1980s (Walsh 2004). One pillar is the “Trim and fit” programme where food served in schools is improved and physical activity in the school curriculum increased. Students found to be overweight participate in special physical exercise programmes, and messages on healthier nutrition choices are reinforced. Obese students who require further assessment and management are referred to the school health service’s students’ health centre for more intensive follow up with doctors and dieticians (Toh et al. 2002). The percentage of overweight schoolchildren has dropped from 14% to 10% between 1992 and 2004 (Walsh 2004). But the programme has only managed to slow the increase in obesity in the general population, not to reduce it. The proportion of obese adults rose from 5.1% in 1992 to 6.9% in 2004 (Government of Singapore 2005).

3.1 Increasing the share of human-powered transport

WHO (2003, p. 131) recommend an increase in physical activity to encounter obesity. In modern, non-agricultural societies, this essentially translates into shifting traffic modes to human power such as biking and walking. One hour of daily cycling or walking would be sufficient to prevent obesity (WHO 2000, p. 114). Unfortunately, in most developing countries there is a rapid shift away from human-powered transport with ensuing consequences for obesity prevalence. Car ownership in China increases the likelihood of obesity by 80% (see Popkin and Gordon-Larsen 2004, p. S 5).

Policies to increase human-powered transport could include (see also list in WHO 2000, p. 193):

- Provision of safe infrastructure for cycling and walking (bike lanes, sidewalks, guarded bike parking lots, rental bikes etc.)
- Increasing cost of car use (parking fees, road pricing, no tax subsidy)
- Reducing maximum car speed
- Prohibiting car access to important areas
- Tax subsidisation (high deductible if proof of biking/walking). In Finland, the company Pekkaniska has introduced monetary incentives for its employees linked to the distance they walk (Pekkaniska 2006).

Policies to support public transport may have a negative effect if the improved public transport system leads to a substitution from human-powered transport modes, which is often observed.

3.2 Reduction in sedentary leisure and increase in physically active leisure activities

In most countries, sedentary leisure activities like television and computer use have increased considerably and saturation is not visible. In 1995, the average US adult spent 2.5 hours per day in front of his television set (Cutler et al. 2003, p. 103). A modal shift of 30-45 minutes to any physical sport would be sufficient to prevent obesity (WHO 2000, p. 114).

While it is extremely difficult to influence leisure time allocation by policy measures, the following policy would in principle be possible:

- Taxation of TV and domestic internet providers according to connection time of user. Taxing the acquisition of the leisure equipment would not make sense as it would increase the use frequency.
- Subsidisation of physical activity, e.g. membership in sports club, provision of fitness programmes
- Provision of infrastructure for physically active leisure, especially in urban areas (playgrounds for children, parks, sports centres)

In Singapore, the share of people doing regular physical exercises (i.e. more than 20 minutes per day on at least 3 days per week) increased from 13.6% in 1992 to 24.9% in 2004 (Government of Singapore 2005).

3.3 Reducing fat content of food

A major factor in the increased incidence of obesity is the increasing availability of cheap food with high fat content, especially of animal origin. Between the late 1960s and late 1990s, food intake of animal origin increased by 8% in industrialized countries and by 109% in developing countries (WHO 2003, p. 15). Fat intake increased by 55% in China, 31% in the EU and 25% in the USA (ibid., p. 18). Societies that managed to keep a high share of vegetables in their diet (Korea and Japan) as well as those that have actively opposed the "fast food culture" (France) have a much lower incidence of obesity than other societies with the same income level (WHO 2003, p. 7). However, the increasing opportunity cost of preparing traditional food and large budgets for advertising "snacks"[5] make it difficult to prevent the modal shift in food.

Cutler et al. (2003) argue that the shift from home cooking to use of industrially manufactured food, particularly in the form of "snacks", is the main explanatory factor for the rise of obesity

[5] In 1992, advertising expenses for chocolate snacks in the UK were 20 times higher than those for vegetables and fruits (WHO 2000, p. 132).

in the USA. Thus, policies that control fat content in manufactured food as well as shift from high-fat to low fat food should play a key role in the fight against obesity. Public health policymakers could learn from anti-smoking policies. Policies at their disposal would be:

- Sales ban for foodstuff above certain fat content in public areas (schools, government offices). Since 2003, several school districts in the US have introduced such bans (Severson and Delgado 2003).

- Elimination of high-fat foodstuffs from meals provided in public institutions (WHO 2000, p. 128). A more lenient version would be nutrition guidelines.

- Advertising ban for foodstuff above a certain fat content (e.g. all types of "snacks"). Sweden banned television advertising for soft drinks aimed at children under 12 in 1991. In 2005, Ireland imposed a ban on television advertisements for sweets and fast food, with the new law prohibiting the use of celebrities and sports stars to promote junk food to kids (Spongenberg 2006).

- Taxation of manufactured food according to its fat content. The proceeds from the tax could be earmarked for preventive action such as transport policy and improvement of food quality in public institutions (see e.g. Nestle and Jacobson 2000).

- Clear labelling of packaged food in drastic terms (e.g. "Eating this foodstuff can lead to heart disease, high blood pressure and diabetes").

Finland and Norway have national food policies that have had some impact in slowing down obesity increases (WHO 2000, p. 188f).

4 Climate benefits of anti-obesity policies

Policies that reduce obesity through an increase of physical activities or a reduction of production and consumption of certain food items can have greenhouse gas benefits through the reduction of fossil fuel use.

4.1 Emission reduction through shift to human-powered transport

If every human in industrialized countries would walk 2.5 km per day, average weight increase would stop. The greenhouse gas benefits of such a replacement of motorized travel by walking would be substantial, reaching up to 100 million t CO_2 for the OECD (see Table 10):

Table 10: Effects of modal shift of 2.5 pkm/day from motorized transport to non-motorized transport

		Total traffic (billion pkm)	Reduction through modal shift to non-motorized transport (billion pkm)	g CO_2 per pkm	Total CO_2 reduction (million t)
Germany, 82.5 million hab.	Car*	907	55.7	140	7.8
	Rail	72.6	4.5	70	0.3
	Total	**1028**	**60.2**	**-**	**8.1**
EU 25, 436.6 million hab.	Car*	4586	307	140	43.0
	Rail	345	24	70	1.7
	Total	**5380**	**331**	**-**	**44.7**
OECD, 1168 million hab.	Car*	13071	799	140	111.9
	Rail	792	149	70	10.4
	Total	**15950**	**948**	**-**	**122.3**

Data for Germany (2004), Source: Bundesministerium für Verkehr-, Bau- und Wohnungswesen 2005, data for EU25 (2003), Source: EU 2005, data for OECD countries (2003), Source: OECD 2005 and for the modal split Wiederkehr and Caid (2004). It is assumed that current users of non-motorized transport continue to use non-motorized transport modes. Air travel is not substituted.

* Occupancy 1.3 passengers per car

4.2 Emission reduction due to reduction of sedentary leisure activities

Sedentary leisure activities are usually linked to use of television and computers. According to U.S. Department of Energy, Energy Efficiency and Renewable Energy (2006), the wattage of a typical television set is 120 W while a PC with monitor uses 250 W. If we now assume that average daily television / PC use is reduced by 1 hour per day throughout the OECD, greenhouse gas reductions of up to 25 million t CO_2 for the OECD can be achieved (see Table 11).

Table 11: Effects of a reduction in television / PC use of one hour per day

	Population (million, 2005)	Electricity use of TV/PC for 1 hour/day (GWh/year)*	CO_2 emissions factor (g/ kWh, 2003)**	Emission reductions (million t CO_2)
Australia	20.3	908	868	0.79
Austria	8.2	367	224	0.08
Belgium	10.4	465	274	0.13
Canada	32.3	1444	221	0.32
Czech Republic	10.2	456	502	0.23
Denmark	5.4	241	356	0.09
Finland	5.2	233	297	0.07
France	60.9	2723	82	0.22
Germany	82.5	3689	499	1.84
Greece	11.1	496	777	0.39
Hungary	10.1	452	421	0.19
Iceland	0.3	13	1	0
Ireland	4.1	183	592	0.11
Italy	58.1	2598	524	1.36
Japan	127.8	5714	441	2.52
Korea, Republic of	48.3	2160	437	0.94
Mexico	105.3	4708	580	2.73
Netherlands	16.3	729	466	0.34
New Zealand	4.1	183	178	0.03
Norway	4.6	206	9	0
Poland	38.2	1708	662	1.13
Portugal	10.6	474	414	0.20
Slovakia	5.4	241	255	0.06
Spain	43.4	1941	381	0.74
Sweden	9.0	402	59	0.02
Switzerland	7.4	331	30	0.01
Turkey	72.1	3224	496	1.60
United Kingdom	60.0	2683	473	1.27
United States of America	296.4	13253	584	7.74
OECD	**1168.5**	**52,225**	**467**	**25.15**

* We assume that 25% of time is spent in front of the computer, and 75% in front of the television. With an average usage rate of 1 person per computer and 1.5 persons per television, average capacity reaches 122.5 W.

** IEA/OECD (2005)

Obviously, many non-sedentary leisure activities will lead to emissions and thus counteract the overall CO_2 reduction (“substitution effect”). As emission factors of such activities are not available, we cannot estimate this substitution effect.

4.3 Emission reduction through reduction of energy-intensive food production

The reduction of production of extremely carbon-intensive food products that promote obesity could generate substantial emission reductions (see Table 9).

5 Barriers to anti-obesity policies and strategies to overcome them

The big challenge regarding policies that reduce obesity is that most of them want to influence deeply ingrained behaviour of individuals in a field that is culturally charged. Government interference in daily routines is not accepted by most citizens in democratic countries. The Singaporean anti-obesity policy has been commented by many Western observers as strange and unacceptable “micro management” of daily lives of individuals. However, anti-smoking policy has shown that tough fiscal and regulatory activities against individual behaviour can be acceptable if a majority feels that the behaviour is generating unacceptable negative societal impacts. Greenhouse gas benefits of anti-obesity policies can accelerate a “tipping point” at which food and sedentary leisure taxation as well as measures to promote non-motorized transport becomes democratically palatable.

6 Conclusions

Obesity is a societal challenge that is on the rise in almost all countries. We have shown that obesity leads to increasing greenhouse gas emissions from transportation, food production and waste management, totalling hundreds of million tonnes on the OECD level. Measures to reduce obesity thus would have substantial greenhouse gas reductions. As obesity reduction measures would likely be "no regret" options that benefit society financially, the big hurdle to overcome is the lacking willingness of society to introduce policy measures that make individuals change engrained behaviour. But the success story of aggressive policies addressing smoking can be a blueprint for fighting obesity – and the greenhouse gas benefits may be an additional incentive to embark on such policies sooner than later.

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