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## Designing lifestyle-specific food policies based on nutritional requirements and ecological footprints

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Expanded understanding of the trends and determinants of food consumption is needed to reduce the ecological impacts of the contemporary agro-food system while also being attentive to broader issues pertaining to health and the environment. Incorporating these additional aspects and formulating meaningful dietary recommendations is a major challenge. This article seeks to highlight differences in ecological footprint (EF) by activity level for various social groups to meet suggested physiological requirements by nutritionists versus actual food consumption. The study is based on a combination of healthy diet requirements (as expressed by national guidelines) and a survey of a representative sample of 1,013 Hungarian adults using a bottom-up approach for calculating EFs. Students and women with small children have a higher than average food-related EF due to their higher nutritional needs. At the same time, the elderly are characterized by lower footprints. Perhaps most interesting is our finding that people with sedentary forms of employment have higher food footprints than those with jobs that require physical labor. We offer recommendations for food-policy planning based on encouraging dietary changes for individuals, differentiated by the nature of their work. The research suggests that dietary policy that improves health often has environmental benefits.

KEYWORDS: food consumption, diets, nutrition, environmental impact, health policy, occupational health

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### Introduction

Food consumption has become an increasingly critical challenge for policy makers and diet more generally is now a target for explicit consumption-related policies. McMichael et al. (2007) argue that in recent years the focal point of interaction between food, energy, and health has shifted radically. Food provides energy and nutrients, but its provisioning requires concomitant energy expenditures. For example, intensive agriculture and overconsumption give rise to a difficult array of challenges harming both the environment and human health. At the same time, ensuring access to adequate food is vital, although overeating and the subsequent consequences of high levels of obesity have reached epidemic proportions in some subpopulations. For example, in the European Union more than 53% of the population has been estimated to be overweight (IASO, 2008) and this fraction is increasing (WHO, 2008). Reductions in meat consumption could lower the risk of obesity, as well as heart disease and cancer (EEA, 2010).

From a global perspective, consumption of energy-dense foods has increased during the last few decades. Disproportionate intake of nutrients and an unbalanced diet indicate low fruit and vegetable consumption and excessive reliance on junk food and meat, which has been linked to neuropsychiatric dis-

orders, high cholesterol levels, and, because of related patterns of physical inactivity, excessive weight and obesity (Duchin, 2005). These conditions impose high health-related costs on society and decrease individual well-being (EEA, 2010). According to the European Environment Agency (2010), increasing caloric intake, together with sedentary lifestyles, is the root of the problem. Contemporary modes of food consumption and production also increase environmental burdens in terms of land and water use, biodiversity loss, and greenhouse-gas (GHG) emissions (Lorek & Spangenberg, 2001a; Tukker et al. 2006; Jackson & Papathanasopoulou, 2008; Druckman & Jackson, 2010; Reisch et al. 2010; Reisch et al. 2011; Tukker et al. 2011; Csutora, 2012).

Overconsumption of meat is of special concern. Thirty-five percent of global GHG emissions generated by agriculture are associated with livestock production. As for the environmental impacts of meat consumption, it has been extensively demonstrated that a heavy meat-based diet requires three times as much land area as a vegetarian diet, due to the resource intensiveness of meat production (Durning & Brough, 1991; Ehrlich et al. 1995; Goodland 1997; Pimentel et al. 1997; Subak, 1999; York & Gossard, 2004).

The linkages among physical activity, food consumption, and environmental impacts have to date

received quite limited attention. While researchers have explored the relationship between actual and healthy food consumption (e.g., Wallén et al. 2004; Collins & Fairchild, 2007; Frey & Barrett, 2007; Mcdiarmid et al. 2011; Vieux et al. 2012), there are few examples of work that have deployed a differentiated approach to consider the nutritional demands of various occupational groups. This article seeks to fill this gap by applying a consumption-based approach both regarding the methodology and the research question, differentiating between the ecological footprints from food consumption of different occupational groups. The next section defines “sustainable food consumption” and “healthy food” and reviews prior studies measuring the environmental impact of food consumption. It is followed by the methodology and the research results.

### Defining Sustainable Food Consumption

Different definitions of “sustainable food consumption” and “sustainable diet” have been advanced over the past few decades. Erdmann et al. (1999) claim that the sustainability of food consumption is predicated on four dimensions: economic, environmental, health, and social. However, they give no guidance as to how these facets should be weighted when putting sustainable food consumption into practice. Leitzmann (2003) contends that sustainable food consumption should be defined as the preference for meatless or reduced meat diets along with organically, regionally, and seasonally produced foods that are minimally processed, ecologically packed, tastefully prepared, and fairly traded. Duchin (2005) claims that a sustainable diet should have a low environmental impact and contribute to preserving human health. Wallén et al. (2004) argue for low-energy input per food item, but also call for a diet that provides nutrients and energy necessary to maintain good health. The definitions of the UK Sustainable Development Commission (Levett-Therivel Sustainability Consultants, 2005) and Lefin (2009) incorporate environmental, health, and social aspects regarding the sustainability of food consumption.

This cursory overview indicates that prior efforts to define sustainable food consumption focus not only on environmental aspects, but also indicate that the health and social dimensions are important. It is moreover clear that the sustainability of food consumption goes beyond just the environmental aspects, as food is a consumption domain with internal impacts on human health and external impacts on the environment. It should be noted as well that the definitions engage with meat consumption in different ways, with the focus variously being either the

maximum amount of red meat consumed or a minimum amount to produce a nutritious diet.

The present study uses Wallén et al.’s (2004) definition of sustainable food consumption, understood to be based on the nutritional requirements proposed by the National Nutritional Institute of Hungary (Rodler, 2004) where the aim is not to minimize meat consumption but to develop a healthy diet and measure its environmental impacts. We assess environmental impacts using the ecological footprint (EF) method, which has been demonstrated to be one of the most useful indicators of sustainability. The EF makes the interpretation of environmental issues and their communication in policy, education, and environmental campaigns easier, so it represents a useful tool for communicating about resource consumption. It must be noted that the EF comprises land use and carbon emissions and other related impacts of food consumption such as methane emissions and water use are not included. However, the EF appears to capture the most important natural resource uses—energy and land use—associated with food consumption (Lorek & Spangenberg, 2001b).

### Measuring the Impact of Food Consumption: A Literature Review

Researchers have devoted considerable attention to the relationships between food consumption and land requirements for food provisioning under different scenarios. Gerbens-Leenes & Nonhebel (2002a) calculated per person land allocations using production data from the Netherlands and conducted an international comparison of fourteen countries that specified the amount of land associated with the largest food categories and identified major consumption patterns reflected in these data.<sup>1</sup> The authors call attention to the fact that future land needs might increase due to population growth in developed countries, changing consumption patterns, and shifts to a diet higher in meat. In other research, Gerbens-Leenes & Nonhebel (2002b) introduced a methodology designed to define the land requirements of more than 100 food categories that can be fit to different dietary patterns. They conclude that large land inputs are due to food consumption among the affluent, for instance of dairy products, wine, beer, coffee, and fats.

Other research has employed the EF concept to determine the agricultural land and natural resource requirements of food consumption. For example, White (2000) compared the EF of meat- and plant-

<sup>1</sup> The fourteen countries were the Netherlands, Belgium, Luxembourg, Denmark, Germany, Greece, Spain, France, Ireland, Italy, Austria, Portugal, Finland, and the United Kingdom.

based diets, showing the significantly higher impact of meat consumption. Chen et al. (2010) conducted an analysis of the environmental impacts of food consumption in rural China using the EF method that showed that the environmental load of food consumption has increased continuously over the past 30 years, particularly because of growth in meat consumption, which has resulted in a greater demand for fodder. Improvements in productivity have compensated for some of the increases in land requirements. In addition, Pimentel & Pimentel (2003) examined the differences between meat- and plant-based diets, showing the higher impact of meat consumption measured in land use [in hectares (ha)], energy use [in kilocalories (kcal)] and water use (in liters). Consumption of food in the United States accounts for 50% of the total land, 18% of non-renewable energy sources, and 80% of water use. Pimentel & Pimentel (2003) found that a meat-based diet requires more embodied energy than a plant-based diet so they regard the latter to be more sustainable. The authors stated that American agricultural production is not sustainable, partly because it is based on excessive reliance on fossil fuels. Significant structural changes would be required if the number of people who eat meat-based diets were to decrease. On the basis of this experience, the current study deploys the EF as an indicator.

The environmental impacts of healthy food consumption have begun to attract increasing attention. Gussow & Clancy (1986), Herrin & Gussow (1989), and Gussow (1999) were the first to argue for aligning environmental and health policy with respect to food consumption. Herrin & Gussow (1989) also analyzed local food consumption from health and environmental perspectives, developing an example for a healthy diet comprising only locally grown food items in the American state of Montana. The authors claimed that even though locally produced food consumption is realizable, it is not evident that consumers would know which food items to select and might not be willing to do so. They emphasize the need for a sustainability-based dietary guide that would be differentiated by region according to the availability of locally produced food types. Gussow (1999) lists the environmental and health advantages of local food consumption.

The direct scientific antecedents of this study are Frey & Barrett (2006; 2007) and Collins & Fairchild (2007) who use EFs to measure the impact of food consumption and to investigate linkages between actual and healthy diets. These authors claim that the EF could be reduced significantly through widespread adoption of healthy diets and the consumption of more local products. However, consuming goods that have been proximately produced does not always

entail a smaller impact as, for instance, growing local vegetables in a greenhouse can have higher environmental impacts than importing the same products (Fuchs & Lorek, 2000). Peters et al. (2007) investigated the land requirements of 42 diets by measuring the impact of fat and meat consumption. They observed almost a fivefold difference (0.18–0.86 ha) in per capita land requirements across the diets and noted that a high-fat vegetarian diet can have greater land requirements than lower fat diets containing meat. Wilkins et al. (2008) examined the land requirements of low-carbohydrate, high-protein diets and that of a diet based on official nutritional recommendations in the United States. The high-protein diet had twice the land requirement of the recommended diet. Stehfest et al. (2009) claim that global carbon-dioxide (CO<sub>2</sub>) emissions could be decreased by as much as 20% by mass shifting to a healthier diet. Friel et al. (2009) and Fazeni & Steinmüller (2011) have similarly demonstrated the potentially significant environmental effects of dietary changes through healthier food consumption. According to Cowell & Parkinson (2003), Stehfest et al. (2009), Risku-Norja et al. (2009), and González et al. (2011), adjusting the structure of food consumption could appreciably reduce environmental impacts. Wilkins et al. (2010) claimed a need to integrate food-system awareness into professional practice and to highlight the importance of jointly managing the health and environmental dimensions of food consumption.

Tukker et al. (2011) analyzed the food consumption clusters of the EU-27 countries and examined the potential impact of a shift toward a Mediterranean diet. The study reported that the greater the reduction in meat desired from a dietary perspective, the more drastically changes are needed in consumption structure, leading to environmentally healthier agricultural practices. Macdiarmid et al. (2011) claimed no significant differences between a healthy diet and a low-impact diet concerning health and environmental impact, which could mean the existence of new synergistic opportunities.

In sum, previous studies have not differentiated the structure of diets according to occupational activity, and so did not account for different nutritional demands. It is this issue that the current article seeks to address.

## Research Methodology

### *Calculation of the EF of Different Occupational Activities*

This study is based on a survey of 1,013 Hungarian adults carried out using the random-walk method combined with the so-called Leslie Kish key, which provides a clear and fixed statistical methodol-

ogy for choosing the household as well as the specific person within the household (Kish, 1949; 1965). The survey was conducted in 2010 in 80 Hungarian communities and is representative in terms of residence, gender, age, and education levels. It comprised several detailed questions about food-consumption patterns and the quantity and frequency choices from eleven food-consumption categories (cereals; tea and coffee; milk; other nonmilk dairy products; potatoes and rice; pasta; meat; cold cuts, ham, and eggs; fruit and vegetables; and bread and bakery products). The survey enabled identification of food consumption in a detailed way, with consumption defined as the amount of food eaten, not accounting for wasted food. To quantify the EF of food consumption, these data were linked to a separate data series that provided footprint intensities. We calculated the EF of food consumption using the following formula.

$$\text{EF of food consumption} = \text{quantity consumed (kilograms per week)} \times 52 \text{ weeks} \times \text{EF intensity (global hectare/kilogram)} \quad (1)$$

In the analysis, the calculations of cropland, carbon-uptake land, and EF intensities were based on Global Footprint Network (2008) data specifically for Hungary, where primary data is given at a product level for Hungarian food production and imports. For each food-consumption category, we calculated the ecological and carbon-footprint intensity per one ton or kilogram (kg) and data for product levels were aggregated and weighted according to the food-consumption statistics of the Hungarian Central Statistics Office (HCSO) (KSH, 2012a). In the EF, both the actual land area required to produce the food items and the carbon footprint were quantified. This is of special importance as a significant fraction of CO<sub>2</sub> emissions are due to an increased production of meat, with clear climate-change ramifications.

$$\text{EF} = \text{carbon footprint} + \text{cropland footprint} \quad (2)$$

Based on the data from the food-consumption patterns reported in the survey and the footprint intensities, we calculated EFs. The EF shows a hypothetical land requirement that allows comparison of results from other countries. Real land use is not considered in this study as the aim is to express the EF requirements due to food consumption. Monetary data were collected for the main household-expenditure categories so that environmental impact could be calculated both from monetary and physical

data, and this provided a control for the reliability of the results.

As the aim of this study was to examine food consumption and EF discrepancies associated with different occupational activities, footprints were calculated for sedentary workers, people engaged in both light and heavy physical labor, students, retirees, and women on maternity leave. Regarding representation of the different levels of physical exertion, the survey results were compared to data from HCSO (KSH, 2012b). According to the survey, people engaged in light and heavy physical labor included both agricultural and nonagricultural workers, while skilled workers were nonagricultural blue-collar workers. Sedentary workers comprised people engaged in occupations not requiring physical exertion. Physical laborers lived mainly in outlying villages and towns rather than Budapest. Sedentary workers tended to be urbanized, with 31% living in Budapest (a further 50% live in other Hungarian cities). As for the skilled workers, 78% of them resided in villages and cities; they are less present in Budapest where 11.3% live. Their living conditions determined their occupational work to a great extent.

#### *Calculation of a Diet Based on Nutritional Needs*

The aim of the study was to examine food consumption across different occupational activities and, furthermore, to quantify and compare the EF of actual food consumption and the EF of a healthy diet differentiated by occupational activity. For this reason, we sought to quantify the structure of a healthy diet and its associated footprint based on energy requirements.

According to James & Schofield (1990), habitual physical activity and body weight are main determinants for the diversity of energy requirements of adult populations with different lifestyles. In calculating energy requirements, physical activity level (PAL) of adult-population groups was multiplied by the corresponding Basal Metabolic Rate (BMR) measured in kcal per day (kcal/day) (FAO/WHO/UNU, 1985). This method was used to define the energy requirements for the different occupational activities. Nutritional requirements for a healthy diet were based on the recommendations of the FAO/WHO/UNU (1985) and Rodler (2004). According to the National Nutritional Institute of Hungary, this guideline is the most current and was developed according to the nutritional requirements of the Hungarian population.

An average, substantial diet for a Hungarian man is 2,400 kcal/day (for sedentary work). We modified this diet by using the energy factors and nutritional demands suggested by Bíró & Lindner (1988) and took into account the different nutritional require-

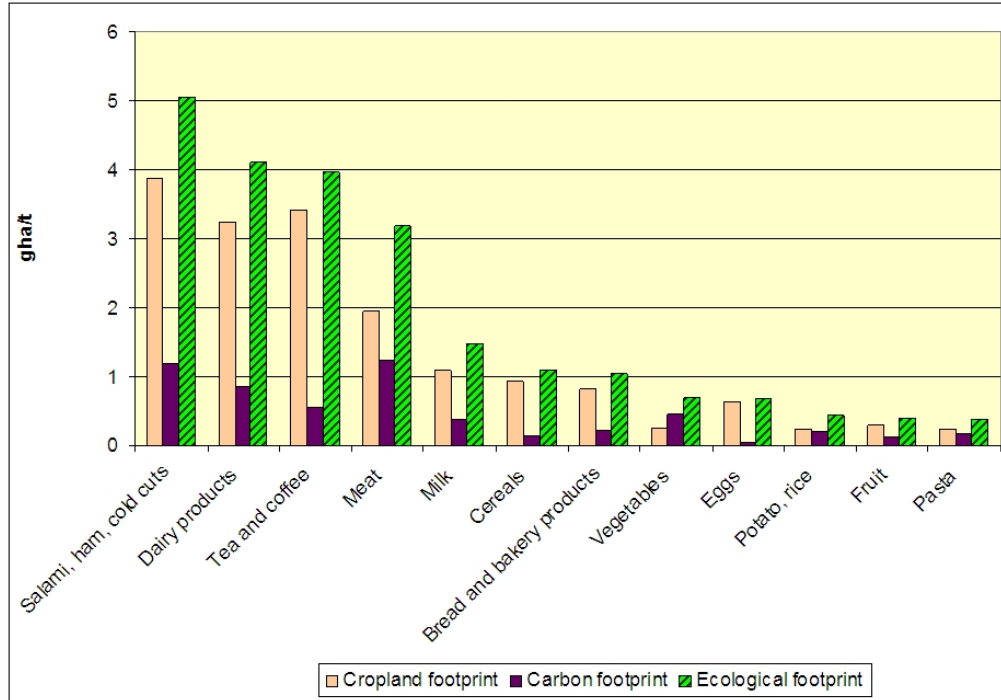


Figure 1 EF intensities of various food categories.

ments and FAO/WHO/UNO (1985) guidelines. After specifying the healthy diet for different levels of occupational exertion, we calculated the EF of these diets. The Appendix shows the energy and nutritional requirements according to activity and age.

## Results

We first calculated footprint intensities. Figure 1 shows these measures in global hectares per ton (gha/t), as well as the land-use and carbon-footprint intensities.

Meat products and cold cuts (e.g., salami and ham) clearly have the highest footprint-intensity values, so the consumption of these food-product groups has high relative impact on the environment as a result of the extensive amount of land required to grow fodder and the energy used in agricultural production.

Next in comparative footprint intensity are dairy products and bread and bakery products. A major part of the total EF is due to land-use requirements and a minor part to carbon emissions. The carbon footprint-intensity values are relatively high for meat products and for pasta. For vegetables, the carbon-footprint intensities are higher than the land-use intensities because of the high energy requirements to operate greenhouses.

Knowledge about EF intensities can help us to quantify which food categories have the largest footprints and carbon intensities and where changes in

the quantity and structure of diets can make the most difference. The total average EF of a Hungarian adult is 1.22 global hectares (gha), while the carbon footprint is 0.33 gha (i.e., about a quarter of the total EF). A significant part the overall EF is attributable to meat (33%), cold cuts (13%), and dairy consumption (14%), while the impact of bread and bakery products (17%) is also quite significant. The major part of the footprint comprises land use (crop and grazing land), but the carbon footprint should also be taken into account, especially if we consider biocapacity limits. In the Hungarian case, the extent of agricultural land is not a binding constraint, while the carbon emissions of fossil-intensive production exceed the carbon-sequestration potential

In a subsequent step, we decomposed the EF to investigate footprints for the different occupational groups (Figure 2).

The footprints of laborers and sedentary workers are nearly equal despite significant differences in their respective levels of physical exertion. Laborers have average EFs of 1.22 gha, while the average EF of a white-collar worker with a sedentary lifestyles is 1.23 gha. The footprint of skilled workers is also higher than that of laborers. The food consumption of sedentary workers is characterized by a high intake of cereals and fruits and vegetables. These food items belong to the healthy and less footprint-intensive food categories, though the increase in the quantity of their consumption contributes markedly to EF. Meat

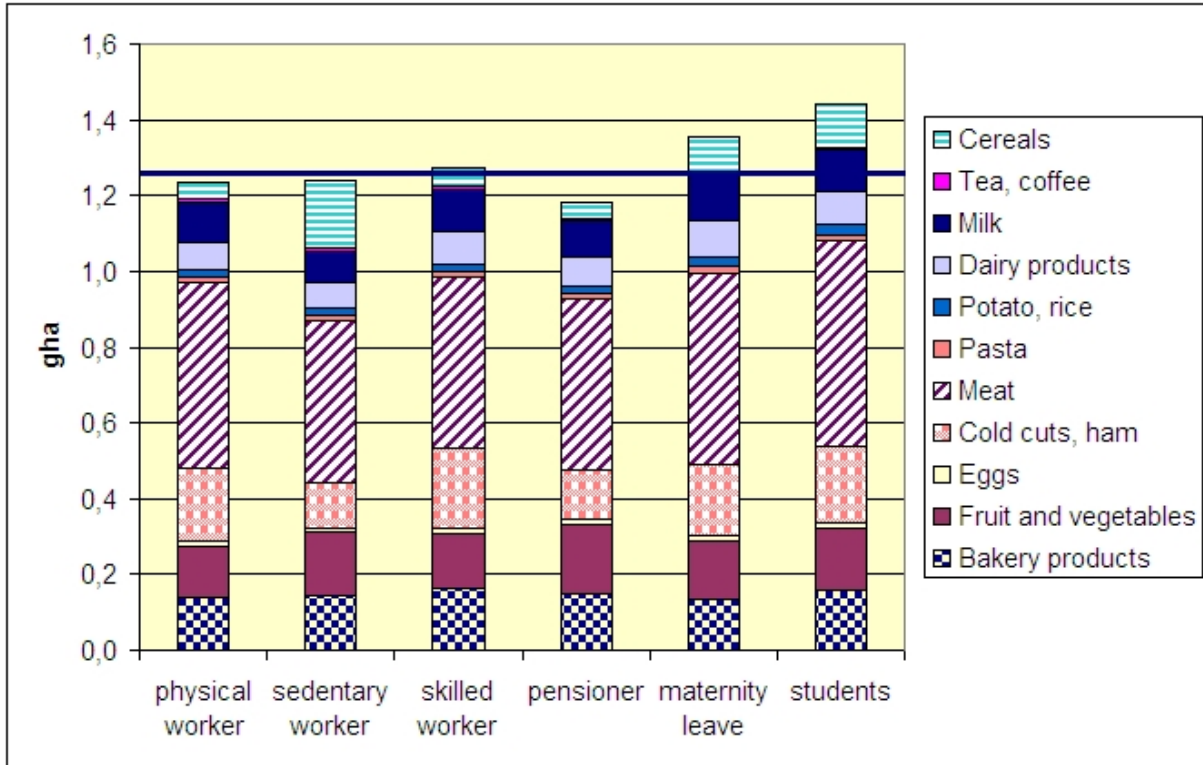


Figure 2 EF of food consumption by occupational activity.

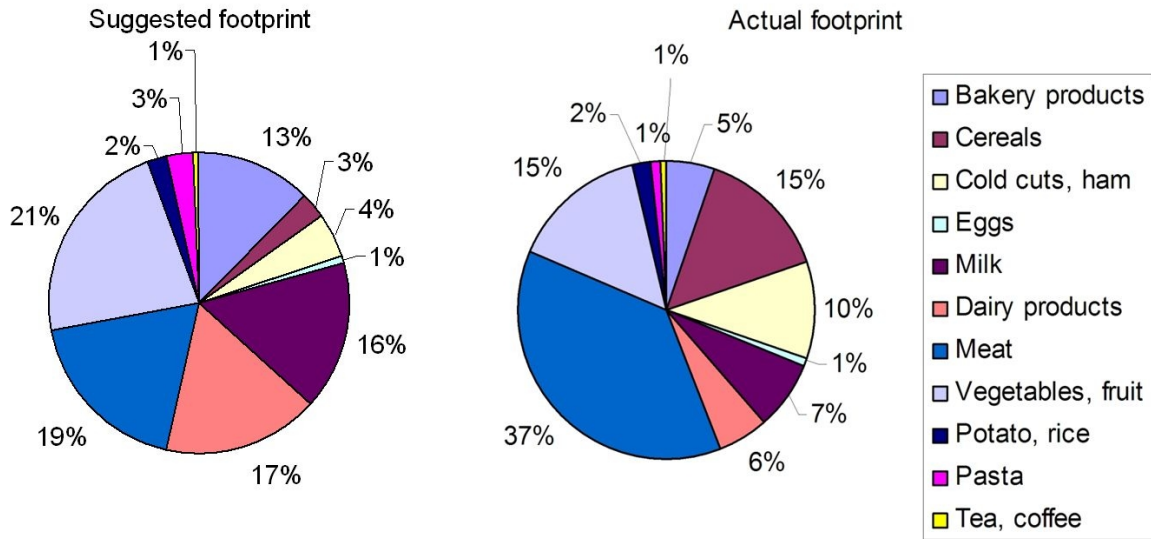
consumption is higher for laborers and skilled workers (due largely to greater consumption of fats and carbohydrates). The same can be said about consumption of bakery products, which is higher for laborers and skilled workers. The EF and food consumption of sedentary workers is larger due to food items typically recognized for their healthfulness, though their higher-than-recommended level of consumption causes a significant footprint increase.

The EF of seniors is less than average due to lower levels of food consumption across all categories, though their meat consumption is slightly higher than nutritional guidelines. Being on maternity leave may require up to a 20–25% higher energy intake; thus, consumption increases for bakery and animal products. However, intake of fruits and vegetables is lower than recommended. These items are not a major source of energy, but contribute significantly to a healthy diet. The high energy demand of students 19–30 years of age is well represented by their increased consumption of food and its associated footprint, which is part of a healthy diet and higher metabolic demands.

One of the aims of our work is to quantify and analyze differences in the EF of food consumption by different levels of physical exertion. It is obvious that individuals who work at jobs that require more energy need to supply this additional energy through

food consumption. To define and calculate an example of the ideal level and type of food consumption (as advanced by nutritional recommendations), we analyzed the guidelines of the FAO/WHO/UNO (1985) and Rodler (2004) and developed a healthy diet for a sedentary worker consuming 2,400 kcal/day. The Appendix shows the recommended energy intake for different levels of activity and the additional energy and additional fat, protein, and carbohydrate needs over sedentary activity. Using these factors, we developed and calculated a healthy diet that considered the increased nutritional demands due to energy expended and quantified the footprints of these diets.

Figure 3 displays the differences due to the variable intensity of work activities. The figure represents the healthy food-consumption footprint according to guidelines developed by the World Health Organization (WHO, 1985) and the National Institute for Food and Nutrition Science (Rodler, 2004), and Hungarian calorie-related data. These sources show that an increase in the consumption of fruits and vegetables is needed. In contrast, meat consumption and cold-cut consumption should be decreased. Thirty-three percent of the typical actual food footprint for Hungarian adult men engaged in sedentary work derives from meat consumption, which is problematic from both a health and environmental perspective.



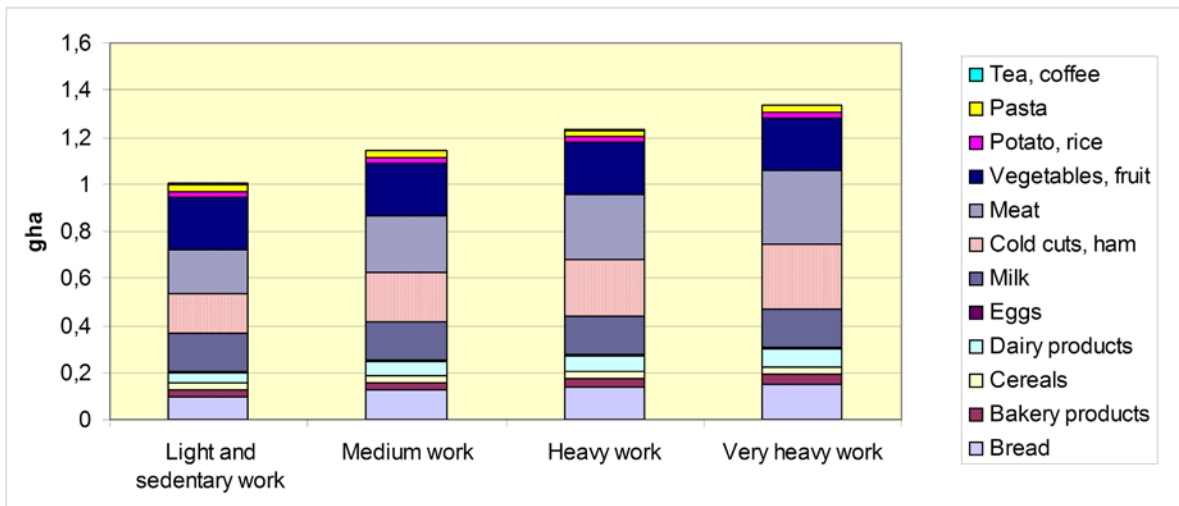
**Figure 3** Comparison of suggested and actual footprints for men who do sedentary work. Source: Authors' own calculations (2012).

A healthy diet is generally characterized by extensive consumption of fruits and vegetables and modest intake of meat (with some milk and dairy products). Considering energy needs, it is light laborers and sedentary workers who should have the lowest EFs and heavy laborers who should have the highest EF, according to standard nutritional guidance (Figure 4).

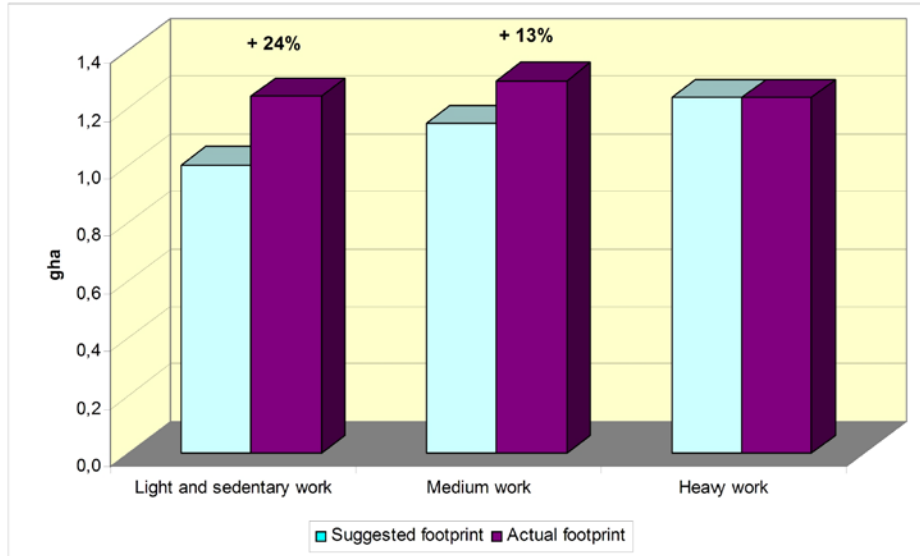
Growth in the use of energy is mainly connected to increased consumption of breads and cereals for optimal healthy consumption (i.e., carbohydrates) and to increases in consumption of meat and dairy products. Moreover, as the level of physical exertion

rises, consumption of bread, cereals, and meat increases. The EF grows in parallel, with elevated meat consumption significantly influencing the overall footprint.

We also note that sedentary workers and medium-intensity laborers consume more and have a larger footprint than heavy laborers, and they have a significantly higher footprint than nutritional guidance suggests is appropriate. The largest gap between recommended and actual diets is observable in sedentary workers, where actual footprints are 24% higher than recommended standards. Heavy physical laborers have the smallest deviation (Figure 5).



**Figure 4** Recommended healthy footprint structure, taking into account physical activity and its energy needs Source: Authors' own calculations (2012).



**Figure 5** Comparison of suggested and actual footprints based on dietary needs. Source: Authors' own calculations (2012).

As for the overall composition of the Hungarian food-consumption footprint, overconsumption is not systemic with respect to all food items. Meat consumption is higher than nutritional guidance recommends, while milk consumption is significantly below dietary targets (according to the Hungarian nutritional recommendations which are relatively high), while the ecological footprint of milk is comparatively high compared to vegetables. This appears to be one instance where footprint and health benefits diverge. There is great variance in the consumption of bakery products. For laborers in Hungary, consumption of food in this category is less than healthy diet standards.

## Discussion

This study has sought to increase appreciation for the health and environmental implications of different patterns of food consumption and to enhance understanding of the EFs associated with various levels of occupational exertion. Results regarding the EFs of different occupational groups show appreciable differences. A seeming paradox is that the food-related EF of sedentary workers is higher than that of physical laborers despite the fact that less active individuals have lower nutritional needs and energy levels than their more active counterparts.

Similarly unexpected is our finding that in Hungary skilled workers appear to have higher food-related EFs than physical laborers. However, consumption of food fulfills not only physiological demands, but serves social and cultural roles. This observation may help to explain the higher consumption

levels of sedentary workers. There are some food categories with great differences across occupational groups, notably fruit and vegetable consumption. We found such consumption higher among sedentary workers; however, vegetable consumption is lower with skilled and physical workers and should be increased.

To sum up, the composition of the food-consumption footprint is far from healthy or optimal. Our results show that sedentary workers and medium-intensity laborers would have to do more to decrease their food-related EFs than heavy laborers, whose consumption can be attributed to their higher energy requirements. Reducing consumption of meat, with its high footprint intensity, and increasing consumption of fruits and vegetables, with their low intensity, would have a double dividend: a lower food-related EF and a healthier population.

We used the consumption data from HCSO (KSH, 2012c) to examine the relationship between income status and healthy consumption and how this relates to the previous results. To explore this correlation, we divided households into five income quintiles. We discovered that as income rises, people tend to eat more unhealthy food (e.g., sugar, fats), and the consumption of healthy fruits and vegetables increases only minimally (Table 1). The consumption of meat especially rises along with income levels. Evidence of a healthier diet is only found among the wealthiest 20% of the Hungarian population that consumes less sugar and fat and relatively more fruits and vegetables. There is an apparent tendency to maintain comparatively high consumption of fats, sugars, and meat even in middle-income families while making supplementary additions of fruits and



**Table 1** Annual food consumption per capita in Hungary by income quintiles (kg) in 2010 (KSH, 2012c).

	Food Consumption (kg per capita)				
	1st Quintile	2nd Quintile	3rd Quintile	4th Quintile	5th Quintile
<b>Cereals</b>	74.3	73.1	78.7	80.1	75.7
<b>Meat</b>	41.1	45.1	50.5	56.9	57.9
<b>Fish, fresh and canned</b>	0.7	1.2	1.4	2.2	2.6
<b>Milk, liter</b>	40.2	44.4	51.6	52.3	58.4
<b>Yogurt, sour cream, liter</b>	7.3	8.7	10.6	12.7	16.5
<b>Cheese, cottage cheese</b>	3.0	4.1	5.2	6.1	7.9
<b>Eggs (number)</b>	113	121.1	138.2	149.2	143.8
<b>Fats</b>	12.5	13.8	15.9	17.1	17.0
<b>Fruits</b>	18.6	26.2	33.5	38.4	49.2
<b>Vegetables and potatoes</b>	52.1	60.1	70.8	79.4	79.2
<b>Sugar</b>	9.8	11.6	12.1	13.9	12.0

vegetables. Such practices foster overconsumption and increase food-related EFs.

### Conclusion

One aim of our research was to examine food consumption and its EF according to different types of activity. Comparing the suggested footprint (based on nutritional needs and a healthy diet) with data on actual footprints shows large differences. As a general comment, the footprint of each group is higher than the suggested one, which means that “overconsumption” and intake of unnecessary energy is occurring. Overall, we find that it is not heavy workers who have the highest footprint; rather, food consumption by sedentary workers is far higher than it should be (based on dietary recommendations). As for heavy laborers, higher footprints would be justified because of their higher energy demands (indeed, our results suggest that their footprint is on average smaller than that for sedentary workers). Comparing the structure of healthy and actual diets for the different occupational groups, we find that meat consumption is higher than recommended for all occupational groups, and changing the dietary structure toward more plant-based food consumption would have both environmental and health benefits. Limitations of the research include that a nutritious and healthy diet may vary due to other determinants which are not taken into account in the present study.

Our results demonstrate significant discrepancies between the EFs of actual diets and healthier alternatives based on nutritional recommendations. The divergence is greatest for sedentary and skilled workers, who could be expected to be more informed and interested in both nutritional and environmental issues. However, these groups typically have higher income levels that likely explain the higher than recommended food consumption. For this category,

there seems to be too much emphasis on what to eat and too little on how much to eat.

Several policy recommendations follow from this investigation. First, there is potential to realize a double dividend by harmonizing environmental and health goals. Such an integrated approach would entail less meat consumption and increased fruit and vegetable consumption, as a diet oriented toward these priorities would likely lead to lower food-related EFs and a healthier population. Second, there is an opportunity to enhance the quality of public communication about healthy diets as—in addition to physical activity—social factors have a strong influence on diet. Food choices not only influence individual health but societal and public health as well because in the long run obese and unhealthy people increase costs to the health system. Third, to induce behavior change adjustments are needed in the composition of diets along with an overall reduction in the quantity of food consumed. However, altering the structure of food consumption is made more difficult by the lock-in effect, which is why public-policy support is needed to transform consumption patterns. Policy and community-based initiatives could help to change how food is consumed, including healthy food and sport initiatives, awareness-raising about footprint and health aspects, and education about healthy living and proenvironmental behavior.

The considerable environmental impacts associated with food consumption constitute a promising area for further research and policy. Major benefits may occur simultaneously for national health systems and food consumption and production systems, moving society toward a more sustainable path.

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## References

- Bíró, G. & K. Lindner (Eds.). 1988. *Tápanyagtáblázat [Nutrition Table]*, 2nd edition. Budapest: Medicina Könyvkiadó (in Hungarian).
- Chen, D., Gao, W., & Chen, Y. 2010. Ecological footprint analysis of food consumption of rural residents in China in the latest 30 years. *Agriculture and Agricultural Science Procedia* 1:106–115.
- Collins, A. & Fairchild, R. 2007. Sustainable food consumption at a sub-national level: an ecological footprint, nutritional and economic analysis. *Journal of Environmental Policy and Planning* 9(1):5–30.
- Cowell, S. & Parkinson, S. 2003. Localisation of UK food production: an analysis using land area and energy as indicators. *Agriculture Ecosystems & Environment* 94(2):221–236.
- Csutora, M. 2012. One more awareness gap? The behaviour–impact gap problem. *Journal of Consumer Policy* 35(1):145–163.
- Druckman, A. & Jackson, T. 2010. The bare necessities: how much household carbon do we really need? *Ecological Economics* 69(9):1794–1804.
- Duchin, F. 2005. A framework for analyzing scenarios about changes in diets. *Journal of Industrial Ecology* 9(1–2):99–114.
- Durning, A. & Brough, H. 1991. *Taking Stock: Animal Farming and the Environment*. Worldwatch Paper 103. Washington, DC: Worldwatch Institute.
- European Environment Agency (EEA). 2010. The European Environment: State and Outlook 2010. <http://www.eea.europa.eu/soer>. March 6, 2012.
- Ehrlich, P., Ehrlich, A., & Daily, G. 1995. *The Stork and the Plow: The Equity Answer to the Human Dilemma*. New Haven, CT: Yale University Press.
- Erdmann, L., Sohr, S., Behrendt, S., & Kreibich, R. 1999. *Nachhaltigkeit und Ernährung [Sustainability and Nutrition]*. Werkstattbericht No. 57. Berlin: Institut für Zukunftsstudien und Technologiebewertung (in German).
- Food and Agriculture Organization/World Health Organization/United Nations University (UNFAO/WHO/UNU). 1985. *Energy and Protein Requirements*. WHO Technical Report Series 724. Geneva: WHO.
- Fazeni, K. & Steinmüller, H. 2011. Impact of changes in diet on the availability of land, energy demand, and greenhouse gas emissions of agriculture. *Energy, Sustainability and Society* 1(1):1–6.
- Fiala, N. 2008. Measuring sustainability: why the ecological footprint is bad economics and bad environmental science. *Ecological Economics* 67(4):519–525.
- Frey, S. & Barrett, J. 2006. *The Footprint of Scotland's Diet: The Environmental Burden of What We Eat*. Perthshire: WWF Scotland.
- Frey, S. & Barrett, J. 2007. *Our Health, Our Environment: The Ecological Footprint of What We Eat*. International Ecological Footprint Conference. May 8–10, Cardiff.
- Friel, S., Dangour, A., Garnett, T., Lock, K., Chalabi, Z., Roberts, I., Butler, A., Butler, C., Waage, J., McMichael, A., & Haines, A. 2009. Public health benefits of strategies to reduce greenhouse-gas emissions: food and agriculture. *Lancet* 374(9706):2016–2025.
- Fuchs, D. & Lorek, S. 2000. *An Inquiry into the Impact of Globalization on the Potential for Sustainable Consumption in Households*. Workshop on Sustainable Household Consumption. November 17–19, Enschede, The Netherlands.
- Gerbens-Leenes, P. & Nonhebel, S. 2002a. Consumption patterns and their effect on land required for food. *Ecological Economics* 42(1–2):185–199.
- Gerbens-Leenes, P., Nonhebel, S., & Ivens, W. 2002b. A method to determine and requirements relating to food consumption patterns. *Agriculture, Ecosystems and Environment* 90(1):47–58.
- Global Footprint Network (GFN). 2008. National Footprint Accounts: Hungary. 2011 Edition for Year 2008. Global Footprint Network, Oakland, CA.
- Giljum, S., Hammer, M., Stocker, A., Lackner, M. Best, A., Blobel, D., Ingwersen, W., Naumann, S., Neubauer, A., Simmons, C., Lewis, K., Shmelev, S. 2007. *Scientific Assessment and Evaluation of the Indicator "Ecological Footprint."* Dessau-Roßlau: German Federal Environment Agency.
- González, A., Frostell, B., & Carlsson-Kanyama, A. 2011. Protein efficiency per unit energy and per unit greenhouse gas emissions: potential contribution of diet choices to climate change mitigation. *Food Policy* 36(5):562–570.
- Goodland, R. 1997. Environmental sustainability in agriculture: diet matters. *Ecological Economics* 23(3):189–200.
- Gussow, J. & Clancy, K. 1986. Dietary guidelines for sustainability. *Journal of Nutrition Education* 18(1):1–5.
- Gussow, J. 1999. Dietary guidelines for sustainability: twelve years later. *Journal of Nutrition Education* 31(4):194–200.
- Herrin, M. & Gussow, J. 1989. Designing a sustainable regional diet. *Journal of Nutrition Education* 21(6):270–275.
- International Association for the Study of Obesity (IASO). 2008. *Overweight & Obesity in the EU27*. London: IASO.
- Jackson, T. & Papatanasopoulou, E., 2008. Luxury or 'lock-in'? An explanation of unsustainable consumption in the UK: 1968 to 2000. *Ecological Economics* 68(1–2):80–95.
- James, W. & Schofield, E. 1990. *Human Energy Requirements: A Manual for Planners and Nutritionists*. New York: Oxford University Press.
- Kish, L. 1949. A procedure for objective respondent selection within the household. *Journal of the American Statistical Association* 44(247):380–387.
- Kish, L. 1965. *Survey Sampling*. New York: Wiley.
- Kitzes, J., Moran, D., Galli, A., Wada, Y., & Wackernagel, M. 2009b. Interpretation and application of the ecological footprint: a reply to Fiala 2008. *Ecological Economics* 68(4):929–930.
- Kitzes, J., Peller, A., Goldfinger, S., & Wackernagel, M. 2007. Current methods for calculating national ecological footprint accounts. *Science for Environment & Sustainable Society* 4(1):1–9.
- Kitzes, J. & Wackernagel, M. 2009a. Answers to common questions in ecological footprint accounting. *Ecological Indicators* 9(4):812–817.
- Koerber, K. & Kretschmer, J. 2001. Zukunftsfähige Ernährungskultur [Sustainable food culture]. *Ökologie und Landbau* 29(120):6–9 (in German).
- Központi Statisztikai Hivatal (KSH). 2012a. Egy Főre Jutó Élelmiszer-Fogyasztás [Food Consumption Per Capita]. [http://www.ksh.hu/docs/hun/xstadat/xstadat\\_eves/i\\_zhc005.html](http://www.ksh.hu/docs/hun/xstadat/xstadat_eves/i_zhc005.html). May 4 (in Hungarian).
- Központi Statisztikai Hivatal (KSH). 2012b. Idősoros Éves Adatok:Munkaerőpiac [Time-Series Data: Labor Market]. <http://statinfo.ksh.hu/Statinfo/themeSelector.jsp?page=2&szs=t=QLF>. February 5 (in Hungarian).
- Központi Statisztikai Hivatal (KSH). 2012c. Az Egy Főre Jutó Éves Élelmiszer-Fogyasztás Mennyisége, Jövedelmi Ötödök Szerint, 2010 [Food Consumption Per Capita by Income Quintiles, 2010]. [http://www.ksh.hu/docs/hun/xtabla/hazt\\_fogy/tahlhf10\\_10\\_06.html](http://www.ksh.hu/docs/hun/xtabla/hazt_fogy/tahlhf10_10_06.html). February 10, 2012 (in Hungarian).

- Lefin, A. 2009. *Food Consumption and Sustainable Development: An Introduction*. Consensus Project WP4. Ottginies: Institut pour un Développement Durable.
- Leitzmann, C. 2003. Nutrition ecology: the contribution of vegetarian diets. *American Journal of Clinical Nutrition* 78(3):657S–659S.
- Levett-Therivel Sustainability Consultants. 2005. *Sustainability Implications of the Little Red Tractor Scheme*. London: Sustainable Development Commission.
- Lorek, S. & Spangenberg, J. 2001a. Indicators for environmentally sustainable household consumption. *International Journal of Sustainable Development* 4(1):101–120.
- Lorek, S. & Spangenberg, J. 2001b. *Environmentally Sustainable Household Consumption*. Wuppertal Paper 117. Wuppertal: Wuppertal Institute.
- Macdiarmid, J. Macdiarmid, J., Kyle, J., Horgan, G., Loe, L., Fyfe, C., Johnston, A., & McNeill, G. 2011. *Livewell: A Balance of Healthy and Sustainable Food Choices*. Surrey: WWF-UK.
- McMichael, A., Powles, J., Butler, C., & Uauy, R. 2007. Food, livestock production, energy, climate change and health. *Lancet* 370(9594):1253–1263.
- Peters, C., Wilkins, J., & Fick, G. 2007. Testing a complete diet for estimating the land resource requirements of food consumption and agricultural carrying capacity: the New York State example. *Renewable Agriculture and Food Systems* 22(2): 145–153.
- Pimentel, D., Houser, J., Preiss, E., White, O., Fang, H., Mesnick, L., Barsky, T., Tariche, S., Schreck, J., and Alpert, S. 1997. Water resources: agriculture, the environment, and society. *BioScience* 47(2):97–106.
- Pimentel, D. & Pimentel, M. 2003. Sustainability of meat-based and plant-based diets and the environment. *American Journal of Clinical Nutrition* 78(3):660–663.
- Reisch, L., Farsang, A., & Jegou, F. 2011. *CORPUS Discussion Paper 3 on Scenario Development for Sustainable Food Consumption*. Brussels: CORPUS.
- Reisch, L., Scholl, G., & Eberle, U. 2010. *CORPUS Discussion Paper 1 on Sustainable Food Consumption*. Brussels: CORPUS.
- Risku-Norja, H., Kurppa, S., & Helentius, J. 2009. Diet choices and greenhouse gas emissions: assessment of impact of vegetarian and organic options at national scale. *Journal of Industrial Ecology* 6(4):340–354.
- Rodler, I. (Ed.). 2004. *Táplálkozási Ajánlások: Adatok a Tápanyagtáblázatból [Nutrition Guidelines: Facts from the Nutrition Tables]*. Budapest: OKK-OÉTI (in Hungarian).
- Stehfest, E., Bouwman, L., van Vuuren, D. P., den Elzen, M., Eickhout, B., & Kabat, P. 2009. Climate benefits of changing diet. *Climatic Change* 95(1–2):83–102.
- Subak, S. 1999. Global environmental costs of beef production. *Ecological Economics* 30(1):79–91.
- Tukker, A., Goldbohm, A., de Koning, A., Verheijden, M., Kleijn, R., Wolf, O., Pérez-Domínguez, I., Rueda-Cantuche, J. 2011. Environmental impacts of changes to healthier diets in Europe. *Ecological Economics* 70(10):1776–1788.
- Tukker, A., Huppes, G., Guniee, J., Heijungs, R. de Koning, A., van Oers, L., Suh, S., Geerken, T., Van Holderbeke, M., Jansen, B., Nielsen, P., Eder, P., Delgado, L. 2006. *Environmental Impact of Products (EIPRO): Analysis of the Life Cycle Environmental Impacts Related to the Final Consumption of the EU-25*. Seville: European Commission Joint Research Center.
- Vieux, F., Darmon, N., Touazi, D., & Soler, L. 2012. Greenhouse gas emissions of self-selected individual diets in France: Changing the diet structure or consuming less? *Ecological Economics* 75:91–101.
- Wallén, A., Brandt, N., & Wennersten, R. 2004. Does the Swedish consumer's choice of food influence greenhouse gas emissions? *Environmental Science and Policy* 7(6):525–535.
- White, T. 2000. Diet and the distribution of environmental impact. *Ecological Economics* 34(234):145–153.
- World Health Organization (WHO). 2008. *Interim First Report on Social Determinants of Health and the Health Divide in the WHO European Region*. Copenhagen: WHO.
- Wilkins, J., Lapp, J., Tagtow, A., & Roberts, S. 2010. Beyond eating right: the emergence of civic dietetics to foster health and sustainability through food system change. *Journal of Hunger & Environmental Nutrition* 5(1):2–12.
- Wilkins, J., Peters, C., Hamm, M., & Reinhardt, E. 2008. Increasing acres to decrease inches: the land requirements of low-carbohydrate diets. *Journal of Hunger & Environmental Nutrition* 3(1):3–16.
- York, R. & Gossard, M. 2004. Cross-national meat and fish consumption: exploring the effects of modernization and ecological context. *Ecological Economics* 48(3):293–302.

**Appendix: Energy and nutritional requirements according to activity (FAO/WHO/UNO, 1985; Bíró-Lindner, 1988).**

<b>Additional Intake (basis = sedentary activity 2400 kcal)</b>	<b>Energy (kcal)</b>	<b>Energy</b>	<b>Protein</b>	<b>Fats</b>	<b>Carbohydrate</b>
<b>Medium work</b>					
19–30	<b>3200</b>	<b>123%</b>	124%	123%	123%
31–60	<b>3050</b>	<b>127%</b>	127%	132%	127%
60–	<b>2800</b>	<b>127%</b>	128%	127%	127%
<b>Heavy work</b>					
19–30	<b>3700</b>	<b>142%</b>	142%	151%	137%
31–60	<b>3500</b>	<b>146%</b>	146%	156%	141%
60–	<b>3300</b>	<b>150%</b>	151%	149%	150%
<b>Very heavy work</b>					
19–30	<b>4200</b>	<b>162%</b>	162%	183%	150%
31–60	<b>4000</b>	<b>167%</b>	167%	190%	155%
<b>Pregnant women and breastfeeding women</b>	<b>+143–550</b>	<b>125%</b>	125%	120%	120%