

Review

Metabolic Food Waste as Food Insecurity Factor – Causes and Preventions

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Abstract: The *Metabolic Food Waste* [MFW (kg of food)], first time developed in 2016 as a new indicator by Serafini and Toti, indicates the amount of food consumed over the nutritional requirements and the impact of this overconsumption on the environment. It is necessary to identify the causes and to develop potential methods to prevent and reduce MFW, at the same time with increasing consumer awareness about unsustainable diets and changing diet habits toward more environmentally conscious consumption patterns. By analysing and corroborating external data available for food waste, nutritional requirements, environmental impact of food waste and consumer behaviour, we identified as primary causes for MFW the lack of nutritional education and little understanding of the nutritional requirements amongst all categories of consumers, no access to appropriate food resources or reduced availability of fresh produced food. We conclude that for the quantification of the negative impact of MFW on both the environment and human health, we need a decisive action to raise consumer awareness for healthy and sustainable diets, together with an uniform worldwide distribution of the nutritious food.

Keywords: food security; sustainable and healthy food choices/systems; metabolic food waste; nutrition; overconsumption

1. Introduction

Overconsumption as a mean of wasting food gained traction in the early 2000s, when Vaclav Smil from University of Manitoba highlighted the growing gap between food production and consumption, mainly in developing countries, mentioning an increase in calorie intake from 1000kcal/day to 1500kcal/day in high-income countries in the last decades. He states that this increase should be considered a wasteful food habit. Since then, the subject of overconsumption has been discussed in literature, being mentioned by Barilla Center for Food & Nutrition (BCFN) and by Serafini and Toti when they introduced the term *overconsumption* to the concept of MFW. The current research aims to identify the causes of overconsumption, as food waste is a major issue in trying to ensure global food security, and wasteful behaviours need to be understood in order to address them. We believe that the main reason for overconsumption and obesity is the lack of nutritional education of the consumers. Informing consumers about their physiological food and educating them in choosing healthy and sustainable food products can have a major impact in reducing the occurrence of food waste in the form of excessive consumption. The main objective of the study is to identify at least one method of prevention when it comes to MFW, together with an outline of the reasons why it occurs [1,2,3].

2. Materials and Methods

In order to understand a multitude of the aspects overconsumption and the relationship between overeating and food waste, we made a comprehensive review of the literature. Understanding an adult's nutritional needs, in relation to gender and intensity

of activity, is essential in trying to assess what can be considered excess nutrients, leading to overweight or obesity. In this regard, analysing Fischer's and Garnett's "Plates, pyramids, planet" and the Barilla's "Double Pyramid", both publications address the issue of recommended diet, overconsumption and their impact on sustainability. Therefore, the recommendation is to consume a precise meal structure [4,5] (Figure 1):

- extras, as sweet, fatty snacks, alcohol (one serving);
- fat and oils (two servings);
- dairy products (three servings) and meat, fish or eggs (one serving);
- bread, cereals, side dishes (for servings) and vegetables and fruits (five servings);
- beverages (six servings).

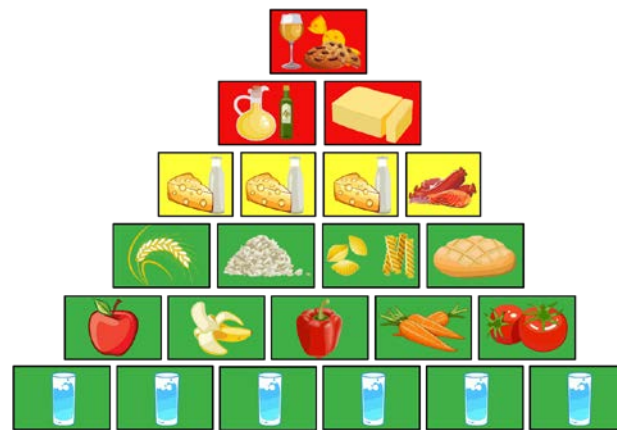


Figure 1. Recommended dietary intake by United Nations "Plates, pyramids and planets" based on idea of S. Mannhardt – authors adaption after [5].

We consulted studies and reports from the last decade in order to analyze the correlation between overconsumption and other food wasting behaviors, the level of knowledge and awareness of healthy and sustainable eating habits, to determine a possible relationship between food waste behaviors and eating habits; existing data on consumer behaviors related to food purchases (checking supplies before shopping, making a list, following the list, proper storage and preparation etc.), in order to assess the presence of responsible consumption habits related to consumption and food waste. The comparative analysis of the previously presented data was used to conduct this study [1,2,4,6,7,8,9,10,11,12].

3. Results and discussion

Human nutrition has changed drastically in the 20th century and beyond. From local and seasonal food, the developed world has made the slow transition to a global approach to food and the availability of fresh produce throughout the year. Nowadays, exotic fruits and vegetables are readily available on every supermarket shelf in the developed world, and the food industry has discovered ways to preserve all foods to extend their validity and availability. Not only that, but the availability of high-quality products such as meat and dairy increased exponentially over the last century, along with an increase in basic income and education. All these factors and many others have led to a change in the human diet, which translates into an increase in the calories consumed daily. This increase is mainly due to an increase in the consumption of animal protein from meat, dairy and eggs. After the industrial revolution, jobs became more and more static, resulting in a decrease in the levels of activity carried out by a person during a day. A sedentary lifestyle and high-calorie diet over the years have led to what we now call "obesity pandemic".

According to data from 2019, 35.20% of the USA population is overweight, and European Union statistics show that in the same year, 52.7% of its population was over-

weight. Globally, the prevalence of obesity tripled between 1975 and 2016, according to data provided by World Health Organization (WHO). These facts raise many questions, not only about the health sector and the economic burden of preventing and treating diseases related to overweight and obesity, but also about the ethics of overconsumption [13,14,15,16,17].

Is it moral and ethical to consume food in excess, knowing the related health and financial burden, while exacerbating the burden on the planetary production system? What are the factors that determine the adoption of an unhealthy diet? What can and should be done to reduce the occurrence of overconsumption in the developed world?

3.1. Overconsumption as food waste

The first scientist to raise the issue of food overconsumption as a waste-eating behaviour is Vaclav Smil (2004). He argues that food production can be optimized not by increasing physical inputs to boost production, but by reducing inefficiencies, post-harvest losses and by “matching more closely actual food needs and availability”. He further states that the level of waste occurring in the food system is “the most offensive demonstrations of human irrationality”. Smil is focusing on the growing gap between food production and consumption. Although North America and Europe are leaders in wasteful behaviours and overconsumption, these are spreading rapidly among the upper classes in middle- and low- income countries due to increasing incomes and the availability of high-caloric foods, as meat, dairy and eggs. The BCFN report from 2012 also emphasizes the idea that overconsumption is a wasteful behaviour and should be addressed in the global fight against food waste. Serafini and Toti went further and developed a new indicator – *Metabolic Food Waste* (MFW) – expressed in kg of food, which corresponds to the excess of food consumed over physiological needs, which leads to overweight and obesity [1,2,3].

The complete information for 86 countries was analyzed by Toti and others, reported for 2017 and these countries were classified in the seven regions of the FAO world. According to them, the global impact of MFW in the world corresponds to 140.7 million tons of food waste associated with overweight and obesity. It is noted that of all the regions analyzed, Europe is responsible for the largest amount of MFW (39.2 million tones), followed by North America and Oceania (32.5 million tones) and Latin America (20 million tones), while the lowest amount of MFW was recorded in Sub-Saharan Africa, with only 5 million tones [18]. (Table 1)

Table 1. Metabolic Food Waste [MFW (tons of food)] associated with overweight and obesity – authors selection after [18].

World Region	MFW [to of food]
Europe (EU)	39,201,410,847
North America and Oceania (NAO)	32,465,755,707
Latin America (LA)	20,022,343,875
Industrialized Asia (IA)	17,190,412,965
North Africa, West and Central Asia (NAWCA)	14,595,049,642
South and Southeast Asia	12,181,476,616
Sub-Saharan Africa (SSA)	5,079,066,441
TOTAL WORLDWIDE	140,735,516,093

It is noteworthy that cumulating the quantities of MFW in Europe and North America and Oceania, the amount is over 50% of the total MFW worldwide, reported in 2017, at the level of 86 countries analysed (Figure 2).

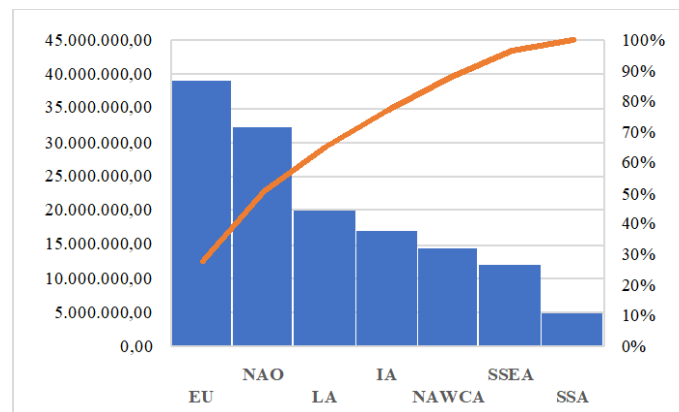


Figure 2. Worldwide distribution of MFW (tons of food) associated with overweight and obesity

MFW can be further developed to express the impact of overconsumption on the environment, such as carbon, water and land footprint. Toti and others argue that excessive consumption of energy-dense foods, such as meat and animal fat, fried foods, dairy products and sweets, represent a significant environmental cost, being the main contributor (approximately 80%) to the increase in GHGs from food production. On the other hand, a balanced diet, based mainly on vegetable foods, is not only a healthier option, but has low risks for the diet–environment–health triangle. BCFN also states in their report that, as consumption in developed countries significantly exceeds the recommended caloric needs, the phenomenon of overeating should be taken into consideration in future discussion about food waste. The Lancet Commission advocates responsible consumers behaviour, encouraging a reduction in animal foods and a more balanced diet, for both environmental but and human health [2,18,19].

3.2. Causes of overconsumption

When we refer to food, overconsumption means overeating, and is the situation in which an individual consumes food above the body's energy requirements, in relation to energy expenditure, leading to excess fat in the body. When practiced constantly for long periods of time, and coupled with lack of physical activity, overeating is the principal cause of overweight and obesity in both adults and children. Another aspect of overconsumption is that it is mainly due to an excessive intake of free sugars, fat, animal products and alcohol [20,21].

The factors that lead to overeating are multiple, and difficult to point exactly, but they can be grouped in more categories: global factors, societal factors, educational factors and individual factors.

3.2.1. Global factors leading to overconsumption: Among the most important factors that have led to an increase in the amount of food globally is the economic growth experienced in the recent decades by economies around the world. Economic growth has been manifested by the increased availability of food resources in the northern hemisphere, due to innovation in agricultural practices that translate into higher quantities of food available for consumption, correlated with a decrease in the price of products previously considered high-end products (meat, dairy). Economic growth has also manifested itself as an intensification of global trade practices, further contributing to increased availability in previously middle- and low-income countries. Economic growth also leads to an increased in per capita income, due to the opening of borders for foreign investors who expand the number of jobs available within the country's borders. Increased availability and income have led to an increase in the amount of food people eat over the years, leading to overconsumption and therefore metabolic food waste [22,23].

3.2.2. *Societal factors leading to overconsumption:* The most important driver of overconsumption, when it comes to societal factors, is the current trend of consumerism. Since the beginning of the twentieth century, during the beginning of mass production of goods, consumerism has spread rapidly due to aggressive marketing campaigns. It is characterized by the purchase of goods and services in an ever-increasing quantity and the rapid withdrawal of goods that are still functional in favor of the “new”. In terms of food purchase and consumption, it encourages a display of wealth through large quantities of food purchased and consumed, over energy requirements, promoted by marketing strategies, which often end as food waste, or by throwing away basket, either by being eaten over the physical needs [24,25].

Another societal factor is the habits of food consumption, specific to every culture in the world. Some cultures have traditions that encourage the consumption of high-calorie food, especially during the holidays, when full meals and full bellies are sign of joy, happiness and wealth.

Another factor leading to overconsumption is the expansion of fast prepared food in all middle to high income countries. The issue with this kind of food venues is that most often the foods sold are high in sugar, salt and fat. All these components are correlated to a high level of satisfaction, leading to repeated consumption and overconsumption. They also lack in the micro and macronutrients needed for normal physical function, so in addition to favoring overconsumption, leading to overweight and obesity, if eaten frequently over a long period of time, it contributes to a deficiency of nutrients [2,26].

3.2.3. *Individual factors:* Individual factors leading to overconsumption are linked to final consumers, their food choices and dietary patterns. This category of factors includes the elements of mental health, as they can affect food consumption patterns - excessive stress can lead to stress-eating behaviors, resulting in overeating; strong emotional periods that can disturb the feeding pattern, also leading to overconsumption. In the case of stressful and emotional eating, the root cause to be addressed is the mental health of the individual (and the ways to deal with emotionally challenging events), not eating behavior - it is just an external manifestation of internal turmoil. For this reason, we will not focus on this paper on the issue of stressful behavior and emotional overeating [2,27,28].

Other factors that lead to overconsumption and subsequently to metabolic food waste, which are directly dependent on the individual and will be further addressed, are considered to be a lack of education and knowledge regarding individual energy needs; the desire to buy and eat associated with a lack of awareness when eating food - eating while walking, working, watching TV; lack of control over food choices - people who are dependent on someone else (the elderly, women, children, young adults); personal preferences of food groups; attitudes towards food waste - negative emotional response (guilt, sadness etc.) when throwing food, not being aware that overconsumption is also food waste [2,3,30,31].

3.2.4. *Lack of education and knowledge regarding energy needs:* In recent decades, the Western world has been bombarded with information about so-called healthy diets, which promise not only to get rid of overweight individuals, but also to improve their long-term condition. This fad diet roller coaster had exactly the opposite results than the desired ones. Knowing that any diet has the reverse, to gain weight and then something extra after it is over, individuals are now in the position to binge diet, following one restrictive diet after another, for fear of not regaining the weight they just they lost her. Another thing to note is that, most of the time, these diets revolve around restriction (Keto diet - restrictive carbohydrates; Paleo diet - dairy, legumes, cereals; low calorie diets; diet elimination food groups; restrictions of food combinations etc.), the body's long term depletion of the basic macro- and micro-nutrients needed for optimal functioning. Individuals lack the basic knowledge and understanding of the principles of functioning of their body, as well as the nutritional requirements to ensure optimal intake, so they

choose to follow a diet for a short time, without being aware that, in fact, a healthy diet is not a diet at all, but rather a way of life. In general, individuals overestimate the amount of protein and fat needed and underestimate the importance of vitamins and minerals found in fruits and vegetables. The result is that they eat far more animal products than the energy requirements and far fewer fresh fruits and vegetables. A study from The Lancet Commission points out that globally, red meat intake is twice the recommended intake, with North America exceeding the recommended intake six times and Europe and Central Asia four times. The same study shows that, compared to the recommended amount of fruits and vegetables consumed, North America consumes only 60% of each category, and Europe and Central Asia consume about 55% of the recommended consumption of fruits and 70% of the recommended vegetables. Both North America and Europe and Central Asia consume more than the recommended amount of red meat, starchy vegetables, eggs, poultry and dairy, but less than the recommended fish, vegetables, legumes, whole grains and nuts. These imbalances in the intake are in line with an unhealthy lifestyle, being clear indicators that the population either does not have the knowledge or chooses not to follow the recommendations of the authorities regarding nutrition [19].

3.2.5. *The impulse to buy and eat related with lack of awareness when eating food - eating while walking, working, watching TV:* Derived from the trend of consumerism, the issue of impulse buying is consistent with behaviors such as overbought and overeating. This behavior is mostly manifested either in response to external factors - promotions, discount prices, product display, store layout, other marketing strategies that encourage consumers to buy more than necessary, or in response to internal (personal) factors - predisposed to be influenced by marketing strategies, inability to withstand momentary urges (determined by seeing, smelling products), lack of preparation before and during shopping (plan meals in advance, determine the amount needed for each food product, check existent stock at home, make a shopping list, include possible "triggers" in the list, follow the list). Closely related to impulsive buying is impulsive eating. When unrelated to mental health issues, as discussed before, impulsive eating manifests itself as an inability to resist the need to eat, even if you are not hungry at the moment. Impulsive eating behaviors are constantly checking the fridge, eating foods just because they are "there" and triggering the need to eat, unable to resist another bite, even when you are already full and satisfied, eating because you see someone otherwise, they eat and are unable to resist the impulse. Impulsive eating should not be confused with compulsive eating, which is represented by repeated episodes of overeating, even to the point where it creates physical discomfort, but also a constant concern for eating and eating. Compulsive eating is considered an eating disorder and should be addressed by a professional, in order to guide and aid the individual suffering [32,33].

Closely related to impulsive eating is the lack of awareness and mindfulness directed towards the process of food consumption. From family and even community activity, food has become more and more an individual activity. The time allocated for this activity has also changed. If in the past meals were a reason for the family or community to get together and spend time together, today the meals are mostly taken alone, in a hurry. The busy schedules and the various other activities that fill our days make eating in a dedicated time slot, almost an impossibility. Most of the time, the meal is cramped between meetings and deadlines or is consumed in a hurry, while going from one place to another, therefore, mindful eating becomes more and more a treat. Another thing worth mentioning is that even if we take time for a meal, modern society likes to eat while watching TV, an activity that exhausts the meal and the attention it deserves. Nutritionists strongly claim the lack of awareness and mindfulness when eating is one of the main causes of overeating. Not paying attention to the food, and to the signals that our body sends us, correlated with eating too fast, inevitably leads to overconsumption. This

behavior, if constantly repeated, will lead to overweight and obesity and related health issues [1,2,4,5,30,31].

3.2.6. Personal preferences, allergies, intolerance: It is known that each individual is unique, and food preferences are no exception. Each of us has personal tastes and tends to like some foods more than others. Others suffer from food allergies and intolerances, making it impossible to eat certain food. This, in turn, makes the effort to create a single diet for all to be futile [4,30].

Food preferences can lead to overconsumption of certain foods, such as meat, dairy, fats, and carbohydrates, which trigger a higher reward response, to the detriment of other foods such as fruits and vegetables, which are healthier and more beneficial for us, but it does not trigger the same neural reward. Another aspect to consider is that when we eat foods that we like, we tend to eat more than we need to, to ensure our sense of satisfaction. As with any other trigger of the reward system, the more and more often we eat what we like, the more we want to eat it, which generally leads to long-term overconsumption, leading to overweight and obesity. Food preferences can be recognized and controlled by changing the pattern of consumption to a healthier one, which includes all food categories, in the recommended amount for each individual [4,32].

People who are affected by allergies and intolerance are guided to replace foods that pose a threat with appropriate foods, in terms of their micro- and macro-nutrient content, to ensure adequate dietary intake. People suffering from allergies and intolerance are not advised to abuse a food group in order to replace the energy needs corresponding to the food they can not eat. For example, someone may be allergic to nuts, but this does not mean they should consume excessively fish to ensure the intake of Omega-3 fatty acids, as this element is also found in vegetable oils, flax seeds, chia seeds and leafy vegetables [4,19,30].

3.2.7. Lack of control over food choices - people who are dependent on someone else (elderly, children, young adults, people with disabilities): Overconsumption of food can be an effect of personal situation, as is the case with children and young adults, the elderly, people with disabilities and some women who have no control over the food they eat.

In the case of children and young adults, the elderly in the care of others and the disabled who need constant care, they are in the situation to eat what the person in charge of their care provides or cooks for them. If the person does not have the knowledge related to the energy needs of a child in particular or of the individual in general, it can easily lead to all forms of malnutrition, including over-nutrition. This is the case for many overweight and obese children who are fed an inadequate diet or are asked by their supervisor to finish everything on the plate, even if it is too much for them. In adulthood, this behavior of finishing food on plate will persist, even without supervision, and will eventually be practiced with their own children, creating a continuous chain of over-nutrition. In the case of the elderly, they may be overfed due to concerns about their general health. The person in care of an elderly may not realize that the energy requirements of the elderly are lower than those of older adults, due to changes in the body but also to decreased physical activity. Therefore, the elderly may be asked to eat more than they need, with good intentions – a concern for their health, which leads to overweight and obesity, which are even more problematic for geriatrics [17,34,35].

3.2.8. Attitudes towards food waste: The way individuals relate to food waste differs greatly, from a total disregard for the negative aspects of food waste to an almost compulsive fear of food waste. It should also be borne in mind that overconsumption as food waste is a new concept and still unknown to consumers. Until recently, the only problems with overconsumption were the health risks of being overweight and obese. Moral attitudes toward food waste, such as guilt or remorse for throwing away waste, often lead to overconsumption. Individuals do not yet realize that eating over the needed amount is a

waste of resources, which has a negative impact on personal health. There are many ways to deal with leftovers – from better meal or portion planning to reusing leftovers to creating new meals or even preserving them safely for later consumption – which does not involve excessive consumption [6,8,10,29,36].

3.3. Methods to prevent overconsumption

Prevention of metabolic food waste is the most effective way for address both the problem and its effects - health issues, environmental issues, moral issues. Unfortunately, universally valid ways to prevent people from engaging in irrational overconsumption practices have not yet been found. With the level of complexity that our current society presents, it is impossible to address every factor that underlies the metabolic food waste. We must not forget that overconsumption is a problem specific to the middle to high income strata of society, while individuals who are currently in the lower strata are still affected by insufficient food resources available or the inability to access these resources due to limited or nonexistent trading opportunities for those resources.

Another aspect of consumption to consider is that economic theory holds that consumers continue to act in an irrational manner, making decisions based on feelings, beliefs, and heuristics, not taking into account the facts presented, but the feelings they experience when buying or consuming a product. This is the case with food technologies for example, when consumers who faced food designed by humans, such as genetically modified products, edible films with nanotechnology coating or meat grown from stem cells, perceive it as unnatural as disgusting. The same flawed belief system applies to foods marketed as healthy: the consumer strongly beliefs that healthy foods cannot be tasty, although there are not scientific studies to prove that indeed healthy food cannot be tasty [37,38].

In view of all the above reasons, we believe that preventive actions should be strongly consumer-oriented. As mentioned in the introductory section, we want to identify at least one possible method of prevention MFW, which can be applied globally, regardless of geographical location, food system structure or diet choice. Focusing on consumer behavior, we assume that the greatest impact on reducing the appearance of the world MFW has the education of consumers around the world.

Nutritional information on the energy intake required for the optimal function of the body system should be available from the earliest stages of life, and rational intake behaviors should be encouraged and rewarded from childhood. It is known that in the early years, memory functions like a sponge, absorbing every piece of information it receives. It is also known that strongly developed and established early behaviors tend to remain stable in adulthood. Therefore, we hypothesize that children's nutrition education, targeted at each stage of development, has a strong potential to change current consuming behaviors. Educating children also has great potential to indirectly educate the adults around them. Families tend to evolve together, and members influence each other, so the educated child is more likely to influence their parents in making better dietary decisions [39,40].

From an adult perspective, it is more difficult to change flawed behaviors and beliefs, but in political theory and behavioral sciences, nudging or choice architecture, a concept popularized in 2008, has been proven to increase the likelihood of positive behavioral change and promote adoption of healthier way of life. It has been shown that nudging has a greater impact on choice than any restrictive methods, based on imposition, coercion, banner or corrective actions. An example of pushing the consumer to choose a healthier option (for example fresh fruits) is to place them at eye level. As a method that has been shown to work in previous studies, we hypothesize that actions aligned with global consumer education, combined with nudging practices to guide the choice of a healthier option, could have a major positive impact on reducing the incidence and prevalence of MFW globally. We believe that continuous education in food and nutrition is of great importance, as knowledge of the facts and gentle guidance

together are the best strategy for orienting consumers towards a healthy alternative of life. As there are no external influences that would lead the consumer to overcome his prejudices, this is seen as an internal effort. But knowing about biases and how to overcome them is a first step in empowering the consumer to make rational, fact-based decisions rather than irrational biased decisions born of misconceptions [29,41,42].

We therefore hypothesize that the best way to prevent MFW and its effects is to start nutrition education in the earliest stages of development, associated with adults nudging practices, where necessary.

4. Conclusions

The present paper aims to identify the potential causes of Metabolic Food Waste (MFW) and to formulate a hypothesis on the prevention of MFW. We focused mainly on the causes related to consumer behaviour and highlighted the most common once. The list of causes is by no means exhaustive, as a complete list of factors leading to overconsumption would require extensive, globally applied studies without guaranteeing that the causes are exhausted, so the causes presented in this paper cover a wide range of MFW.

As a possible preventative approach to the problem, we focused on early childhood education, with great potential to influence the behaviour of their responsible adults, and the niche architecture or choice associated with long-life education, addressing both nutritional and rational thinking, as a method of guiding adults to the behavioural changes needed to reduce the incidence and prevalence of MFW and its effects.

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Authors Statement: The authors do not wish to attack any individual that suffers from overweight or obesity due to genetic factors or other health issue that determines weight gain. We are aware that overweight and obesity have multiple causes, and not all of them are well defined or treatable, so we do not condemn the people that are in this unfortunate situation. We also refrain from body shaming any individual that does not correspond to the societal model of beauty, as we do not care for, nor condone the society standards regarding beauty norms. We appreciate the beauty of being different, and do not acknowledge any standard of beauty, past or present, as being valid. We simply address the issue of overconsumption as a wasteful behaviour that also leads to weight gain, over the healthy limits of the human body. We also want to draw attention to ethical consumption. Food waste, in its generality, can also be analyzed as a form of selfishness. In the meantime, studies are developed on how to lose weight and educate the population to reduce food waste, and other people, adults and children, suffer from famine, suffer of malnutrition and even die of hunger. And in the meantime, we are writing studies... This is the main problem of food waste.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Smil, V., Improving Efficiency and Reducing Waste in Our Food System. *Environmental Sciences* **2004**, 1(1), pp. 17–26, Available online: <https://doi.org/10.1076/evms.1.1.17.23766> (accessed on 20 March 2022).
2. Barilla Center for Food & Nutrition, Food waste: causes, impacts and proposal, 2012.
3. Serafini, M., Toti, E. Unsustainability of Obesity: Metabolic Food Waste. *Frontiers in nutrition* **2016**, Available online: <https://www.frontiersin.org/article/10.3389/fnut.2016.00040> (accessed on 20 March 2022).
4. Barilla Center for Food and Nutrition. Double Pyramid 2016, Available online: <https://www.barillacfn.com/m/publications/food-waste-causes-impact-proposals.pdf> (accessed on 20 March 2022).
5. Fischer, C.G., Garnett, T. Plates, pyramids, planet. Developments in national healthy and sustainable dietary guidelines: a state of play assessment, University of Oxford, FAO Publisher, 2016.

6. Schmidt, K., Matthies, E. Where to start fighting the food waste problem? Identifying most promising entry points for intervention programs to reduce household food waste and overconsumption of food. *Resource Conservation and Recycling* **2018**, 139:1-14, Available online: <https://www.sciencedirect.com/science/article/pii/S092134491830274X> (accessed on 20 March 2022).
7. Conrad, Z., Niles, M.T., Neher, D.A., Roy, E.D., Tichenor, N.E., Jahns, L. Relationship between food waste, diet quality, and environmental sustainability. *PLoS One* **2018**, 13(4), Available online: <https://doi.org/10.1371/journal.pone.0195405> accessed on 23 March 2022).
8. Kymäläinen, T., Seisto, A., Malila, R. Generation Z. Food Waste, Diet and Consumption Habits: A Finnish Social Design Study with Future Consumers. *Sustainability* **2021**, Vol. 13.
9. Prescott, M.P., Burg, X., Metcalfe, J.J., Lipka, A.E., Herritt, C., Cunningham-Sabo, L. Healthy Planet, Healthy Youth: A Food Systems Education and Promotion Intervention to Improve Adolescent Diet Quality and Reduce Food Waste. *Nutrients* **2019**, Vol. 11.
10. Romani, S., Grappi, S., Bagozzi, R.P., Barone, A.M. Domestic food practices: A study of food management behaviors and the role of food preparation planning in reducing waste. *Appetite* **2018**, 121, pp. 215–227.
11. Stancu, V., Haugaard, P., Lähteenmäki, L. Determinants of consumer food waste behaviour: Two routes to food waste. *Appetite* **2016**, 96, pp. 7–17.
12. Stefan, V., van Herpen, E., Tudoran, A.A., Lähteenmäki, L. Avoiding food waste by Romanian consumers: The importance of planning and shopping routines. *Food Quality and Preference* **2013**, 28(1), pp. 375–381. Available online: <https://www.sciencedirect.com/science/article/pii/S0950329312002066> (accessed on 20 March 2022).
13. Eurostat. Overweight and obesity - BMI statistics 2019, Available: online: https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Overweight_and_obesity_-_BMI_statistics (accessed on 20 March 2022).
14. Eurostat. Over half of adults in the EU are overweight 2021, Available online: <https://ec.europa.eu/eurostat/web/products-eurostat-news/-/ddn-20210721-2> (accessed on 20 March 2022).
15. WHO. Obesity and overweight, Available online: <https://www.who.int/news-room/fact-sheets/detail/obesity-and-overweight> (accessed on 23 March 2022).
16. World Population Review. Most Obese Countries 2021, Available online: <https://worldpopulationreview.com/country-rankings/most-obese-countries> (accessed on 23 March 2022).
17. Yang, Z., Huffman, S.L. Nutrition in pregnancy and early childhood and associations with obesity in developing countries. *Matern Child Nutrition* **2013**, 9(S1), pp. 105–119, Available online: <https://doi.org/10.1111/mcn.12010> (accessed on 20 March 2022).
18. Toti, E., Di Mattia, C., Serafini, M. Metabolic Food Waste and Ecological Impact of Obesity in FAO World's Region. *Frontiers in Nutrition* **2019**, 6:126, doi: 10.3389/fnut.2019.00126, Available online: <https://www.frontiersin.org/article/10.3389/fnut.2019.00126> (accessed on 20 April 2022).
19. Willett, W., Rockström, J., Loken, B., Springmann, M., Lang, T., Vermeulen, S., Garnett, T., Tilman, D., De Clerck, F., Wood, A., Jonell, M., Michael, C., Line, J.G., Fanzo, J., Hawkes, C., Zurayk, R., Rivera, J.A., De Vries, W., Majele, S.L., Ashkan, A., Abhishek, C., Herrero, M., Agustina, R., Branca, F., Lartey, A., Fan, S., Crona, B., Fox, E., Bignet, V., Troell, M., Lindahl, T., Singh, S., Cornell, S.E., Reddy, K.S., Narain, S., Nishtar, S., Murray, C.J.L. Food in the Anthropocene: the EAT–Lancet Commission on healthy diets from sustainable food systems. *The Lancet* **2019**, 393(10170), pp. 447-492, Available online: <https://www.sciencedirect.com/science/article/pii/S0140673618317884> (accessed on 20 April 2022).
20. FAO. Food-based dietary guidelines, Available online: <http://www.fao.org/nutrition/education/food-dietary-guidelines/background/sustainable-dietary-guidelines/en/> (accessed on 20 April 2022).
21. Wikipedia. Overeating, Available online: <https://en.wikipedia.org/wiki/Overeating#:~:text=Overeatingistheexcess food,specific episodes of over-consumption> (accessed on 20 March 2022).
22. Gerbens-Leenes, P.W., Nonhebel, S., Krol, M.S. Food consumption patterns and economic growth. Increasing affluence and the use of natural resources. *Appetite* **2010**, 55(3), pp. 597–608, Available online: <https://www.sciencedirect.com/science/article/pii/S0195666310005118> (accessed on 20 March 2022).
23. Marques, A.C., Fuinhas, J.A., Pais, D.F. Economic growth, sustainable development and food consumption: Evidence across different income groups of countries. *Journal of Cleaner Production* **2018**, 196, pp. 245–258, Available online: <https://www.sciencedirect.com/science/article/pii/S0959652618316603> (accessed on 23 March 2022).
24. Aschemann-Witzel, J., De Hooge, I., Amani, P., Bech-Larsen, T., Oostindjer, T. Consumer-Related Food Waste: Causes and Potential for Action. *Sustainability* **2015**, 7(6), pp. 6457-6477
25. Wikipedia. Consumerism, Available online: <https://en.wikipedia.org/wiki/Consumerism> (accessed on 23 March 2022).
26. Jeffery, R.W., Baxter, J., McGuire, M., Linde, J. Are fast food restaurants an environmental risk factor for obesity? *International Journal of Behavioral Nutrition and Physical Activity* **2006**, 3(2), Available online: <https://doi.org/10.1186/1479-5868-3-2> (accessed on 20 April 2022).
27. Rajan, T.M., Menon, V. Psychiatric disorders and obesity: A review of association studies. *Journal Postgrad Medicine* **2017**, 63(3), pp. 182–190, Available online: <https://pubmed.ncbi.nlm.nih.gov/28695871> (accessed on 23 March 2022).
28. Sarwer, D.B., Polonsky, H.M. The Psychosocial Burden of Obesity. *Endocrinology & Metabolism Clinics of North America* **2016**, 45(3), pp. 677–688, Available online: <https://pubmed.ncbi.nlm.nih.gov/27519139> (accessed on 23 March 2022).

29. Barone, A.M., Grappi, S., Romani, S. The road to food waste is paved with good intentions: When consumers' goals inhibit the minimization of household food waste'', *Resources Conservation and Recycling* **2019**, 3:149, pp. 97–105 (accessed on 20 April 2022).
30. FAO; IFAD; UNICEF; WFP; WHO, The State of Food Security and Nutrition in the World 2020. Transforming food systems for affordable healthy diets, Rome, 2020.
31. United Nations Environmental Programme (UNEP), UNEP Food Waste Index Report 2021, Nairobi, 2021.
32. Houben, K., Nederkoorn, C., Jansen, A. Eating on impulse: The relation between overweight and food-specific inhibitory control, *Obesity* **2014**, 1;22(5): E6–8. Available online: <https://doi.org/10.1002/oby.20670> (accessed on 20 April 2022).
33. Lee, N.M., Carter, A., Owen, N., Hall, W.D. The neurobiology of overeating. Treating overweight individuals should make use of neuroscience research, but not at the expense of population approaches to diet and lifestyle', *EMBO Report* **2012**, 13(9), pp. 785–790, Available online: <https://pubmed.ncbi.nlm.nih.gov/22898978> (accessed on 23 April 2022).
34. Bourdel-Marchasson, J. How to Improve Nutritional Support in Geriatric Institutions, *Journal of the American Medical Directors Association* **2010**, 11(1), pp. 13–20. Available: online <https://www.sciencedirect.com/science/article/pii/S1525861009001364> (accessed on 23 April 2022).
35. Lobstein, T., Jackson-Leach, R., Moodie, M.L., Hall, K.D., Gortmaker, S.L., Swinburn, B.A., James, W.P.T., Wang, Y., McPherson, K. Child and adolescent obesity: part of a bigger picture, *Lancet* **2015**, 385(9986), pp. 2510–2520, Available online: <https://www.sciencedirect.com/science/article/pii/S0140673614617463> (accessed on 23 April 2022).
36. Hazuchova, N., Antosova, I., Stavkova, J. Food Wastage as a Display of Consumer Behaviour, *Journal of Competitiveness* **2020**, 12(2), pp. 51–66, Available online: <https://www.cjournal.cz/files/365.pdf> (accessed on 20 April 2022).
37. Cummings, J., Dhar, R., Welch, N. Irrational consumption: How consumers really make decisions, Available online: <https://www.mckinsey.com/business-functions/marketing-and-sales/our-insights/irrational-consumption-how-consumers-really-make-decisions> (accessed on 20 April 2022).
38. Society for Risk Analysis. The irrational consumer: Decision making based on feelings rather than fact, Available online: <https://phys.org/news/2018-12-irrational-consumer-decision-based-facts.html> (accessed on 20 April 2022).
39. Gopnik, A., O'Grady, S., Lucas, C.G., Griffiths, T.L., Went, A., Bridgers, S., Aboody, R., Fung, H., Dahl, R.E. Changes in cognitive flexibility and hypothesis search across human life history from childhood to adolescence to adulthood, *Proceeding of the National Academy of Sciences of the USA* **2017**, 114(30), pp. 7892–7899, Available online: <http://www.pnas.org/content/114/30/7892.abstract> (accessed on 20 April 2022).
40. Whitebread, D., Bingham, S., Habit Formation and Learning in Young Children. The Money Advice Service **2013**, Available online: <https://mascdn.azureedge.net/cms/the-money-advice-service-habit-formation-and-learning-in-young-children-may-2013.pdf> (accessed on 20 April 2022).
41. Martin, I., Radoi, P.B., Rinovetz, A., Cioban, C., Lile, R.. Management of a new solution to evaluate the effectiveness of the dry fractioning operation. *18th International Multidisciplinary Scientific Geoconference SGEM 2018. Conference Proceedings*. **2018**, pp. 347–352.
42. Moseley, A., Stoker, G. Nudging citizens? Prospects and pitfalls confronting a new heuristic, *Resource, Conservation and Recycling* **2013**, 79, pp. 4–10, Available: <https://www.sciencedirect.com/science/article/pii/S0921344913000955>.