



FOOD WASTE-OBESITY NEXUS: AN EXPLORATORY ANALYSIS

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ABSTRACT: *One-third of the world produced food is wasted according to FAO (2011). As well, obesity has tripled since 1975 (WHO, 2018). The aim of this paper is to identify the relationship between food waste and obesity in terms of perceptions and behaviors in Egypt. to achieve this objective, an exploratory analysis is carried out considering factors to be tested affecting both phenomena identified by the recent literature. Results indicate that the relation between the two factors is found statistically significant. Additionally, the individual's perception about food waste and obesity was examined at the household level. The findings suggest considering these factors when developing new policies and campaigns for food waste/obesity reduction.*

Key words: *Food waste, Egypt, consumer behavior, attitudes, obesity.*

INTRODUCTION

According to FAO (2011) report, 32 percent of the world-produced food was lost or wasted in 2009; this estimate was based on the mass of loss or waste, which does not take into consideration the energy in food products. Whereas, Lipinski *et al.* (2013) converted the FAO's loss and waste estimates into calories and found that the food loss and waste (FLW) accounts for 24 percent of all produced food. Additionally, the authors distributed the share of world FLW by region in 2009 and found that North Africa, west and central Asia contributed with 7 percent. The United Nations aims to "halve per capita global food waste...by 2030" (Delgado *et al.*, 2017). Recently, the impacts of foods and dietary patterns on the environment can be assessed using different ecological footprints in terms of water, carbon and land use (FAO, 2013). As such, food and animal products are found to be the main contributors to GHGs emission, as they require considerable amounts of natural resources according to Tilman and Clark (2014).

1. Importance of study and research problem

The research line that focus on foods and dietary impact on health, the evidence clearly shows that the increase in food energy supply was associated with an increase in population average body weight. Globally, the share of men with BMI of 25 kg/m² or greater increased from 28.8% to 36.9%, and women from 29.8% to 38.0% during the period 1980 and 2013 (Vandevijvere *et al.* 2015). According to WHO fact sheet (2018) obesity has tripled since 1975 with more than 1.9 billion adults were overweight out of which 650 million are obese, additionally, 41 million children under the age of 5 were overweight or obese in 2016. Furthermore, the WHO fact sheet have identified different drivers for this issue such as the increased intake of energy-dense foods that are high in fat, the increase of physical inactivity resulted from the increasingly inactive nature of many jobs, transportation methods, and increasing urbanization. As well as the changes of dietary and physical activity resulted from societal, changes and lack of cross-cutting

policies from different sectors and coordination among actors across the value chain. Individual dietary patterns regarding food choice, nutrient, and phytochemical content are tightly linked to nutritional sustainability and environmental protection (15–17). The food waste – obesity nexus has been ignored so far in quantitative assessments at household levels. This paper links the definition developed by Serafini and Toti (2016) regarding food waste, which is “food eaten above physiological needs, manifesting as obesity, should be considered as waste” with food waste definition developed by (FAO, 2013; HLPE, 2014). In this work, the BMI will be used as indicator for obesity.

Investigating food waste at the household level in Egypt is important because, at the quantity level, Egypt is ranked 52nd, on a scale of 1 to 67 ranked countries, Russia is the highest food waste contributor according to the BCFN report, (BCFN, 2018). At the nutritional level, Egypt is facing two challenges, first is the “economic growth-nutrition disconnect.” High economic growth rate is not linked with a reduction in chronic child malnutrition, during the 2000s. The second challenge is the presence of chronic undernutrition and over-nutrition simultaneously (because of excess consumption of calories). Both issues are noticeable in Egypt compared to other developing countries (Ecker *et al.*, 2016).

Alebsheshy *et al.*, (2016) carried out a literature review following a framework developed by (McLeroy *et al.*, 1988; Koplan *et al.*, 2007) and found that there is a significant increase in obesity with more than one-third of the population suffering from obesity. It is more than twice prevalent in females (46%) as compared to males (22%) and yet there is no programs developed that address this issue nationally. The authors found that

women are the most burdened with obesity and it increases with age, wealth, unhealthy diet, physical inactivity, and urban residency as well as an increase of obesity in the poor. Mowafi *et al.* (2014) using multinomial logit have shown that across all socioeconomic status (SES) levels of education, household expenditures, household assets, subjective wealth, obesity is prevalent in a study of 3993 households. Whereas it is growing at a faster rate among the poorer people (Hoebela *et al.*, 2019; Lakerveld and Mackenbach, 2017). A series of systematic reviews carried over the last decade (Alebshehy, 2016; Aitsi-Selmi *et al.*, 2012) have indicated that there is no definite single factor is related with obesity. Except only two factors are likely to correlate consistently with weight, which are urban sprawl and land use mix. In the US, literature has shown that residents living in sprawling suburbs with low density are more likely to be obese. The other factor is that evidence show a better mix among commercial, industrial, agricultural, recreational, residential, and institutional is associated with less obesity. This is attributed to the increased active modes of travel.

2. Source of data and study area of the research question

This study focuses on the metropolitan area of Cairo. It is one of the most populated areas in Africa and the biggest in Egypt, with a population size of 9.5 million in 2017, whose 42.8% is urbanized (CAPMASS, 2019). Studies focusing on food waste quantification and relating it to obesity are scarce at the national level. The sample size was determined by random sampling stratified by age and gender in the city of Cairo. To perform the stratification, the census and population secondary data of the CAPMAS were used (CAPMAS, 2019). Stratification was performed as shown in Table 1. The larger sample size implies a

smaller error in the information obtained, although on the contrary, at the same time it implies a greater time for obtaining said information. For a confidence level of 95.5% ($K = 2$), a p and q equal to 0.5 in an infinite population (inhabitants), 1000 respondents were interviewed in order to incur a sample error lower than 10%.

3. The objective and contribution of the research paper

The objective of this work is to identify the factors influencing the individuals' food waste decisions, as well as studying the effect of these factors on food waste behavior. The contribution is first relating individuals' obesity as food waste behavior with perceptions. Second, this study contributes to the scarce literature on the household level in a North African metropolitan area, as a case to investigate food waste – obesity nexus.

The paper is organized as follows: Next section describes the methodology that explains The third section reports the main results of the study. The last section presents the conclusions and policy implications.

METHODOLOGY

This section briefly describes the research methodology used to achieve the objectives set. Specifically, the design of the questionnaires and

samples, as well as the analysis techniques used, are described. First, we analyze factors affecting food waste and factors affecting obesity, and then analyze the relationship between both concepts. The questionnaire consists of three parts: In the first part, levels of knowledge and attitudes of consumers towards food waste were analyzed, respondents were asked about types and quantities of food being wasted, food choices, prices, cultural backgrounds. In the second part, attitudes and knowledge of consumers towards obesity issue were analyzed, respondents were asked about health benefits that they seek, nutrients necessary to face a certain health issue, food diets and motives to change to new diets. Respondents were asked about their weight and height to calculate their Body Mass Index (BMI). Finally relating food waste quantities with BMI is analyzed.

1. Descriptive analysis

A descriptive analysis was performed in order to provide summary information of the food waste quantities and BMI index were obtained, that is, how the sample is characterized. For continuous variables questions, the mean and standard deviation have been calculated and for discrete questions, the frequencies for the different levels of the variable (Tables 2 and 3).

Table 1. Sample structure

	CAPMAS data			Sample data		
Size	9,539,673			1000		
Age	Total	Male	Females	Total	Male	Females
Less than 25	847,141	51%	49%	266	52%	48%
From 26 to 35	1,497,894	51%	49%	248	53	47%
from 36 to 45	1,141,044	51%	48%	226	49%	51%
From 46 to 55	912,248	52%	47%	260	51%	49%

Table 2. Profile of sample respondents for the food waste quantities

	Average	Minimum	Maximum	Standard deviation
Food waste quantities (grams)	632	150	2000	578

Table 3. Profile of sample respondents for the BMI index

	BMI ranges according to WHO	Sample size =1000
Underweight	<18.5	2%
Normal	18.5 to 25	13%
Overweight	25 to 30	44%
Obese Class I (Moderately obese)	30 to 35	33%
Obese Class II (Severely obese)	35 to 40	8%

2. Bivariate analysis

As a complement to the descriptive analysis, bivariate analyses have been used to determine if pairs of variables are related to each other. In particular, what is about determining is the statistical significance of the possible differences observed. Depending on the type of variable to analyze, we have used the Chi-square test and the analysis of variance (ANOVA) or Pearson's correlation coefficient. To analyze the relationship between two discrete variables, the contingency tables and the Chi-square test are calculated whose null hypothesis is that both variables are independent of each other. When it is tried to relate a quantitative variable and another discrete one, the analysis of the variance (ANOVA of a factor) is used, which allows to determine if different groups of individuals have opined in the same way or not on a quantitative variable. When the two variables are continuous, the correlation coefficient "R" is used. The correlation coefficient indicates the degree of linear association between two variables but does not indicate which of the two variables

influences the other, and the researcher must resolve this situation.

3. Multivariate Analysis

Multivariate analysis is a group of statistical techniques that allow, through its application, to simultaneously analyze more than two variables. The set of techniques used are factor analysis and cluster analysis

Factorial analysis. This analysis has been used in order to summarize the assessment provided by respondents for those questions measured from 1 to 7 using a Likert scale. This analysis allows summarizing the valuations provided by respondents in a smaller number of variables, called factors that are characterized by not being correlated with each other. This facilitates its inclusion in subsequent analyzes without excessive loss of the informative content provided by the original variables as it is based on the idea that when a number of interrelations are observed between several phenomena, they may be due to the existence of some underlying phenomenon, not directly measurable. This underlying phenomenon is called Factor. In other words, factor analysis

condenses the information provided by a set of k variables into a set of w components or factors, $w < k$. Each w is a linear combination of the k variables. (Hair *et al.*, 2014)

Cluster Analysis. To segment consumers, cluster analysis has been used, which aims to group individuals according to some predetermined selection criteria. The resulting segments must be homogeneous within the group and heterogeneous between groups. Cluster analysis methods can be hierarchical and not hierarchical (recommended to group large data sets). In this work, a non-hierarchical cluster has been used. This technique allows classifying individuals into an established number of groups, trying to maximize variance between groups and minimize variance within the group. This approach is recommended when an important volume of data is available and the objective is to classify individuals and know the characteristics of each segment instead of analyzing the hierarchical structure of individuals (Hair *et al.*, 2014).

Specifically, the K-Means method has been applied that allows an individual assigned to a group at a certain step in

the process to be reassigned to another group at a later step if this optimizes the selection criteria. This analysis serves to subdivide consumers, that is, they group individuals according to some criteria (classify and know the characteristics of each segment). The K-Means method was applied to allow an individual assigned to a group at a certain step in the process, could be assigned to another group at a later step and thus optimize the selection criteria. Once consumers are profiled for each group based on socio-demographic aspects, consumer behavior and attitudes towards food waste and obesity, these variables are crossed with other variables to see if there are correspondences.

RESULTS AND DISCUSSION

1. Descriptive results

In Figures 1-6, the sample distribution is analyzed according to socio-demographics. In this case, the participants live in households sizes range between 4 and 5 members, with 49% University education, and 66% enrolled in the food subsidy program and 64% outside medical insurance and 40% with lower than monthly 3 thousand EGP, finally 70% lives in the suburbs.

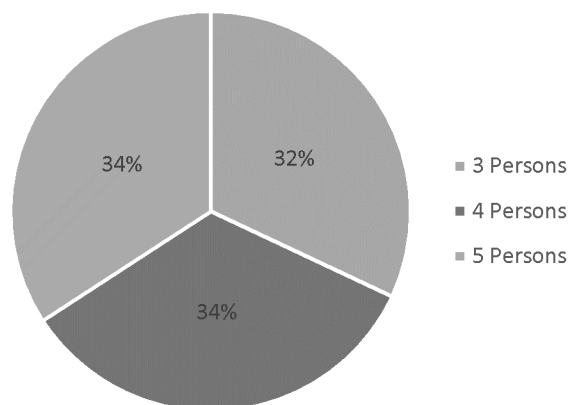


Figure 1. Household size

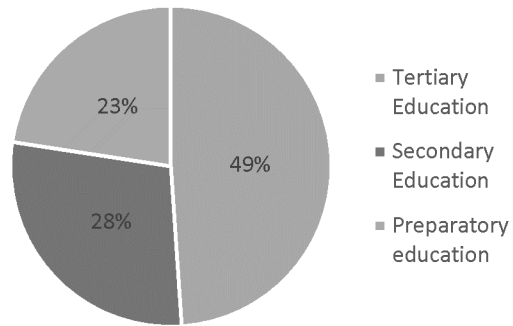


Figure 2. Education level

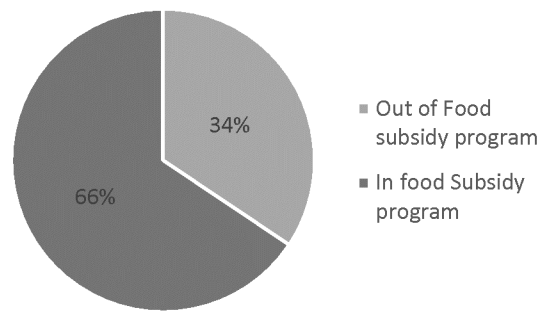


Figure 3. Food subsidy program

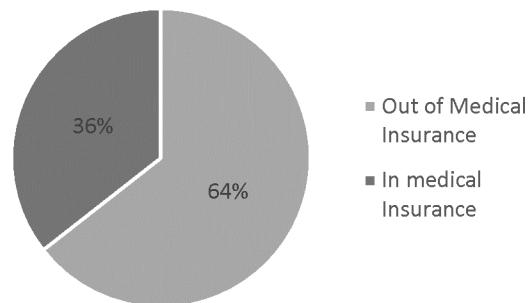


Figure 4. Medical Insurance

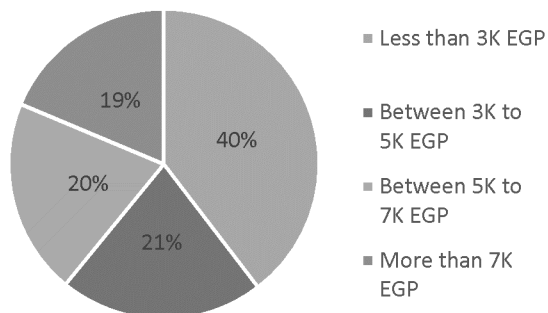


Figure 5. Income Level

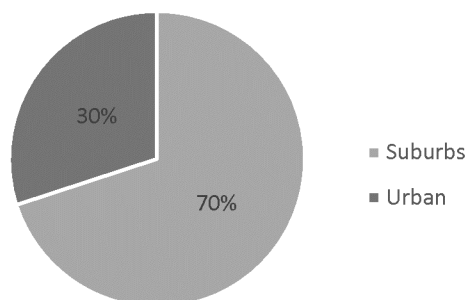


Figure 6. Localities

2. Bivariate analysis

Pairs of variables have been crossed to establish whether there is a statistically significant relationship. Due to the nature of the variables studied, a Chi-square test has been performed to analyze pairs of qualitative variables and in the case of pairs of qualitative and quantitative variables, the analysis of variance (ANOVA) has been used.

2.1. Relations between food waste perceptions with socio-demographic variables

The objective of this part of the analysis is to find a profile of the citizen of Cairo who waste food. The results of crossing these variables, which are shown in Table 4 below, are all significant at 5% except for the relationship of gender and Age with food waste that was not significant.

2.2. Relation between Food waste quantities with food purchase and obesity

The ANOVA results are presented in Table 5 and are interpreted as follows: when crossing the BMI index with the statement food waste quantities, an average of 31.15 was obtained which indicates that respondents throw away

less than 632 grams/day are suffering from obesity problem. On the other hand, those respondents who throw away more than 632 grams/day are not suffering from obesity problem. For the case of food purchase, respondents that tend to be responsible for purchasing food throw away less than 632 grams/day compared with those who throw away more than 632 grams/day.

3. Multivariate analysis

3.1. Factorial analysis

Factor analysis has been used to identify a smaller group of underlying dimensions of a scale with minimal loss of information. Table 6 shows the description of the variables obtained from the Exploratory Factor Analysis (EFA). This part aims to reduce the number of food waste, and obesity claims to a number of underlying factors, and it is proposed to apply those dimensions to help shape the sample of consumers. The KMO index and Bartlett's sphericity test results show the degree of correlation between the variables and are indicative of the validity of the factor analysis. KMO index = 0.72 is classified as middling (medium), and being closer to one, more certain that the data is correlated (Table 7).

Table 4. Results of the relation between food waste perception and socio-demographics

	Through less than 632grams/day (%)	Through More than 632grams/day (%)
Gender		
Male	49	52
Female	51	48
Age		
18-35	26.7	25.5
26-35	24.7	27
36-45	24	23.4
46-55	24.6	24.1
Education level		
Preparatory education	49.5**	48.9**
Secondary education	31.5**	21.9**
Tertiary Education	19**	29.2**
Income levels		
Lower than 3K EGP	38.8**	41.1**
Between 3K to 5K EGP	23.4**	17.1**
Between 5K to 7K EGP	21.3**	18.6**
More than 7K EGP	16.5**	23.2**
Enrolled in the food subsidy program		
Enrolled	36**	31**
Not enrolled	64**	68**
Family size		
3 – 5 members	31.8*	32.1*
5 – 7 members	32.5*	36.3*
More than 7	31.8 *	35.4*

** , [*] Statistically significant at 5%[10%]

Table 5. Results of the ANOVA analysis.

		Mean	95% confidence level for mean	
			Lower limit	Upper limit
BMI index	Lower than 632grams/day	31.15	30.73	31.57
	More than 632grams/day	29.12	28.68	29.57
Responsible for food purchase	Lower than 632grams/day	0.59	0.55	0.62
	More than 632grams/day	0.52	0.47	0.58

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Table 6. Description of latent variables

Constructs	Items	
Food Waste	Q_65	I consider myself familiar with the problem of food waste
	Q_66	I know a lot about the problem of food waste
	Q_67	Within my circle, I consider myself an expert on the problem of leftovers
Obesity	Q_70	I find myself aware of the problem of obesity
	Q_71	Think we need more information on the problem of obesity
	Q_72	Within my circle, I consider myself an expert on the problem of obesity
Environment	Q_56	Human beings have the right to alter the environment in order to meet their needs
	Q_61	The balance in nature is strong enough to withstand the effects of modern industrial societies
	Q_62	It has been greatly exaggerated by the problem of "environmental crisis" caused by humanity

Table 7. Exploratory factor analysis results

Constructs	Indicators	Factor loadings	Communalities h²
Food Waste	Q_65	0.678	0.478
	Q_68	0.648	0.435
	Q_67	0.679	0.488
Obesity	Q_70	0.604	0.418
	Q_71	0.630	0.421
	Q_72	0.575	0.349
Environment	Q_56	0.632	0.437
	Q_61	0.628	0.425
	Q_62	0.601	0.368

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.727
Bartlett's Test of Sphericity	Approx. Chi-Square	489.355
	Sig.	.000

Three factors were developed, the first factor represent the food knowledge about food waste problem representing

the level of awareness about the issue, the second factor represent the level of knowledge about obesity problem and

the third factor represent the level of environmental awareness.

3.2.Cluster analysis

It is an analysis to identify the groups of respondents according to different aspects and group them by common characteristics. The variables according to which the population has been segmented are the three factors that resulted from the factor analysis. The factor scores obtain from the EPA done in the first step has been introduced in the cluster analysis (Table 8).

The first segment represents 23.8% of the sample surveyed. This cluster is characterized by people with little knowledge about the food waste problem, obesity and thinks that the less concern about the environment. This indicates that they carry out personal actions that do not minimize food waste, or consume health food as well as are not environmentally friendly activities.

The second segment is more numerous, 35% of respondents belong to it. They are not knowledgeable of the obesity problem. They are people who are quite or very concerned about food waste problem and who show a positive relationship with style factors, that is, always or almost always undertake personal actions that respect the environment or minimize food waste. Yet they are not familiar with the link between food waste and obesity. The third segment is the largest, 40.8% of respondents belong to it. They are knowledgeable of the three issue of food waste/obesity problems. They are people who are most concerned about health and who show a positive relationship with style factors, that is, always or almost always undertake personal actions that minimize food waste and consuming food that is healthy.

Table 8. Final Cluster Centers

	Cluster		
	1	2	3
Food waste	-1.29847	.71235	.13937
Obesity	-.49824	-.76360	.95318
Environment	-1.13540	.40831	.30805

ANOVA for the cluster analysis						
	Cluster		Error		F	Sig.
	Mean Square	df	Mean Square	df		
REGR factor score 1 for analysis 3	294.417	2	.411	997	715.646	.000
REGR factor score 2 for analysis 3	318.092	2	.364	997	874.098	.000
REGR factor score 1 for analysis 1	202.275	2	.596	997	339.253	.000

Conclusions

The interest in food waste/obesity challenges have been becoming especially important in recent years due to scientific evidence and the agreement of the international community regarding its seriousness (Abdelradi, 2018). Governments have adopted mitigation and adaptation measures, the industry begins to include measures of social responsibility and sustainable production, increasing awareness of the problem these two issues, begins to lead a more environmentally friendly lifestyle and sometimes it even mobilizes to food demand that is more healthy, environmentally friendly and responsible consumption.

In this context, investigating the nexus between these two issues has not received much attention. For this reason, this exploratory study is an attempt to identify the relationship between both factors. The main objectives of this study are to understand consumers' perceptions towards food waste and obesity, in the context of relating behaviors with perceptions. In the development of the work, information about the food waste/obesity, the attitudes of citizens regarding this issue and mitigation and adaptation policies were sought, then deepening the relationship using quantities wasted and BMI index. Based on what was investigated in the previous literature (Abdelradi, 2018), some hypotheses were established that were closely linked to the objectives set out in our study. Therefore, a survey was carried out in Cairo and the results were subjected to descriptive, bivariate, and factorial and cluster analyses. The conclusions, linked to the objectives of the work and the implications that they entail, are explained below.

In the first place, it should be noted that the objectives set have been achieved:

1. Investigate knowledge and opinion about the food waste

The results of the survey show that the citizens of Cairo know the problem of food waste/obesity and think that it is serious. This shows that the population of the city of Cairo is aware of the seriousness of the problem and takes interest in the information related to the subject.

2. Understand whether citizens take personal actions to face food waste/obesity challenges

The results of the analysis suggest that citizens are increasingly encouraged to lead a more environmentally friendly lifestyle. However, it has been found that the actions that involve greater personal effort are those that citizens almost never perform, while those actions that require little personal effort are those that citizens frequently carry out.

3. Food waste and Obesity nexus

The results suggest that citizen that waste more food has lower BMI index and vice versa. This shows that there is a need to be an awareness campaign that links the two issues together and not to deal with an individual basis only.

Finally, if they are helped, consumers can influence how food is going to be produced by exercising their right to choose what they buy. To easily choose the options that are more healthy and environmentally friendly and in the right quantities to avoid food waste. It is essential that information related to food waste/obesity mitigation and the reduction of the environmental impact of agri-food products is communicated to the consumer from all fronts, starting

from food labels awareness campaigns, industry and consumer organizations and translates into information campaigns, educational programs and other initiatives resulting from the dialogue of all parties.

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العلاقة بين هدر الغذاء والسمنة: تحليل استكشافي

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الملخص العربي

تُهدر ثلث الأغذية المنتجة في العالم وفقًا لتقرير منظمة الأغذية والزراعة (2011). كذلك ، تضاعفت السمنة ثلاث مرات منذ عام 1975 (منظمة الصحة العالمية ، 2018). الهدف من هذه الورقة هو تحديد العلاقة بين هدر الطعام والسمنة من حيث السلوكيات المستهلكين في مصر. لتحقيق هذا الهدف ، تم إجراء تحليل استكشافي مع مراعاة العوامل التي يجب اختبارها والتي تؤثر على كلتا الظاهرتين في الدراسات الحديثة. تشير النتائج إلى أن العلاقة بين هذين العاملين وجدت ذات دلالة إحصائية.

1. التحقيق في المعرفة والرأي حول هدر الطعام. تظهر نتائج المسح أن المستهلكين في مدينة القاهرة يعرفون مشكلة هدر الطعام / السمنة ويعتقدون أنها خطيرة. هذا يدل على أن سكان مدينة القاهرة يدركون خطورة المشكلة ويهتمون بالمعلومات المتعلقة بالموضوع.

2. فهم ما إذا كان المواطنون يتخذون إجراءات شخصية لمواجهة تحديات هدر الطعام / السمنة. تشير نتائج التحليل إلى أن المواطنين يتم تشجيعهم بشكل متزايد على قيادة نمط حياة أكثر ملائمة للبيئة. ومع ذلك ، فقد تبين أن الإجراءات التي تنطوي على قدر أكبر من الجهد الشخصي هي تلك التي لا يؤديها المواطنون أبدًا تقريبًا ، في حين أن تلك الإجراءات التي تتطلب القليل من الجهد الشخصي هي تلك التي ينفذها المواطنون كثيرًا.

3. الربط بين هدر الغذاء والسمنة. تشير النتائج إلى أن المستهلك الذي يضيع المزيد من الطعام لديه مؤشر كتلة الجسم أقل والعكس صحيح. هذا يدل على أن هناك حاجة إلى حملة توعية تربط المسألتين معًا وليس التعامل معها على أساس فردي فقط.

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