Association of increased monetary cost of dietary intake, diet quality and weight management in Spanish adults

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Abstract

Higher monetary diet cost is associated with healthier food choices and better weight management. How changes in diet cost affect changes in diet quality and weight remains unknown. The aim of this study was to assess the impact of changes in individual monetary diet cost on changes in diet quality, measured by the modified Mediterranean diet score recommendations (MDS-rec) and by energy density (ED), as well as changes in weight and BMI.

We conducted a prospective, population-based study of 2,181 male and female Spaniards aged 25 to 74 years, who were followed up to the 2009-2010 academic year. We measured weight and height, and recorded dietary data using a validated food frequency questionnaire. Average food cost was calculated from official Spanish government data. We fitted multivariate linear and logistic regression models. The average daily diet cost increased from 3·68±0.0·89€/8·36MJ to 4·97±1·16€/8·36MJ during the study period. This increase was significantly associated with improvement in diet quality (Δ ED and Δ MDS-rec p<0·0001). Each 1€ increase in monetary diet cost per 8·36MJ was associated with a decrease of 0·3 kg in body weight (p=0·02) and 0·1 kg/m^2 in body mass index (p=0·04). These associations were attenuated after adjusting for changes in diet quality indicators.

An improvement in diet quality and better weight management were both associated with an increase in diet cost; this could be considered in food policy decisions.

Introduction

A healthy diet is paramount for physical and mental health [1,2], and improving population diets was declared a priority area of action at the United Nations High Level Meeting on Prevention and Control of Non-Communicable Diseases[3]. Diet quality depends on personal food choices, which are driven by food prices as well as by culture, taste, and convenience[4]. Epidemiological evidence indicates that better diet quality is associated with higher diet costs[5]. Furthermore, higher price indices for fruits and vegetables were linked to higher BMI in children aged 2-9 years[6].

From 2000 to 2010, diet cost increased disproportionately in European countries, with the greatest increases in South European countries such as Spain (31·2%), compared to 17·2% in Germany or 20·6% in Sweden[7]. During that same decade, food prices rose more sharply in Spain for healthy food choices, compared to less healthy foods[8]. The cost of foods low in energy density and rich in nutrients, such as fruits, increased by 51·0%, while pastries or confectionary products, high in energy density but low in nutrient density, increased by 10·1% and 23·1%, respectively. High-density energy consumption has been related with low nutrient adequacy[9,10], weight gain[11], and risk of obesity[12].

It is unknown how increases in individual diet cost, driven by rising food prices, affects consumers' food choices and, consequently, overall diet quality. Therefore, the aim of the present study was to analyze the prospective association between changes in individual diet cost and changes in diet quality in a representative Spanish population. Additionally, we determined the impact of changes in diet cost on body weight.

Material and methods

Participants

Data were obtained from a population-based survey conducted in Girona (Spain) in 2000 and 2009. The baseline survey examined a randomly selected, population-based sample of 3058 men and women aged 25 to 74 years (participation rate: 71·0%). Of the 3058 participants in the baseline survey in 2000, 2715 non-institutionalized participants who still resided in the catchment area in 2009 were invited to participate in the follow-up study (online Supplementary Figure S1) and 2181 of these individuals attended the re-examination in 2009-10**.** This represents a 19·7% loss to follow-up after 10 years, resulting in an acceptable follow-up rate of 80·3%. Finally, 3·2% (n=69) of participants had missing dietary data at baseline or at follow up and were excluded from analysis. The final sample size included 2112 participants with complete follow-up data. Participants were duly informed and signed their consent to participate in the study. The project was approved by the local Ethics Committee (CEIC-PSMAR, Barcelona, Spain).

Dietary assessment

Food consumption was determined using a validated food frequency questionnaire, administered by a trained interviewer at baseline and at follow-up[13,14]. In a 166-item food list including alcoholic and non-alcoholic beverages, participants indicated their usual consumption and chose from 10 frequency categories ranging from never or less than once per month to six or more times per day.

Monetary diet cost

Food prices were obtained from the food price database of the Spanish Ministry of Economy and Competitiveness[8] The average prices for many food items (not including commercial fast foods) are updated every month in this database. For this study, we calculated food prices for 2000 and 2010, based on the average cumulated prices reported for each of those two years. Prices were not available for the following foods (2%): paella, cannelloni, and pizza. Prices for fast food items were obtained by a search of corporate web sites. Individuals' daily diet cost and the monetary diet cost per 8·36MJ of energy intake per day (hereinafter, energy-adjusted diet cost) were calculated.

Measurement of diet quality

Diet quality was determined by the adherence to the Mediterranean diet and the energy density of the daily diet. We chose these two indices of diet quality from among the numerous available indicators because of their good construct validity and established association with health outcomes [9-12,15-17].

Modified Mediterranean diet score recommendations (MDS-rec)

Assessing adherence to the Mediterranean diet by a score based on population-based food consumption distribution is, by definition, specific to a particular population, making it difficult to compare results between studies. To overcome the limitation on comparability of results, we calculated the MDS-rec as previously described[18]. Briefly, consumption that meets recommended intakes for Spanish adults for cereals, fruits, vegetables, legumes, fish, olive oil, nuts, and dairy products is coded as 3, consumption at least weekly as 2, and less than weekly as 1 for legumes, fish, and nuts; for the other groups (cereals, fruits, vegetables, olive oil, dairy products), consumption at least daily was coded as 2 and less than daily as 1. For meat (including red meat, poultry and sausages) and dairy products, the score was partially inverted, with consumption more than weekly coded as 1, weekly as 2, and meeting recommended consumption as 3. Moderate red wine consumption (up to 20 g per day) was coded as 3, and more or less than this daily portion was coded as 1.

Energy density

After considering the different methods of calculating energy density[18], we decided to present data on the basis of a dietary density calculation that includes only food items. Foods and beverages have different effects on satiety and energy intake, which in turn affects the association between energy density and body weight[19]. Therefore, total energy density of the diet was calculated by dividing total energy intake from food consumed each day by the total weight of the reported food intake.

Anthropometrics

Measurements were performed by a team of trained nurses and interviewers who used the same standard methods in both surveys. A precision scale of easy calibration was used for weight measurement with participants in underwear. Body weight was rounded up to the nearest 200 g and height was measured to the nearest 0·5 cm. BMI was calculated by [weight (kg) /height squared (m2)]. Body weight and BMI change was defined as the difference between the weight and BMI recorded in 2010 and at baseline in 2000.

Energy misreporting

Individuals with implausible reported energy intake (rEI) were identified by the revised Goldberg method, as described previously[21]. Basal metabolic rate (BMR) was estimated using the Mifflin equation[22]. The rEI : BMR ratio was calculated. The plausibility of rEI was estimated by comparing the rEI : BMR ratio with physical activity levels (PAL). The cut-off values to identify plausible rEI were taken as the confidence limits of agreement between rEI:BMR and PAL, and were based on the coefficient of variation of participants' energy intake, the accuracy of the BMR measurements, and the total variation in PAL, as proposed by Black et al.[23].

Other variables

The validated Minnesota Leisure-Time Physical Activity (LTPA) questionnaire[24,25] was administered by a trained interviewer. Smoking habits and demographic and socioeconomic variables were obtained from structured standardized questionnaires administered by trained personnel. Participants were dichotomously categorized as nonsmokers (never smokers and exsmokers with more than 1 year of smoking cessation) and current smokers (including exsmokers with less than 1 year of smoking cessation). Maximum education level attained was elicited and dichotomously recorded for analysis as primary school vs secondary school or university.

Statistical analysis

General linear modeling procedures were used to compare baseline participant characteristics by quintiles of changes in diet cost and to analyze changes in food group consumption according to low and high changes in energy-adjusted diet cost (1st vs 5th quintile). ANOVA test and polynomial contrasts were used to determine overall *p* and *p* for linear trend, respectively, for continuous variables with normal distribution, and Kruskal-Wallis test to determine overall *p* for non-normal distributions. *P* for linear trend for categorical variables was obtained by Mantel-Haenszel linear-by-linear association chi-square test.

Linear regression models were fitted to analyze the association between changes in energy-adjusted diet cost and changes in MDS-rec, energy density, weight, and BMI. Two models were fitted. The first included three variables: sex (men/women, dichotomous), age (years, continuous), and the corresponding baseline exposure variable. The second added six variables: smoking (yes/no, dichotomous), energy intake (MJ, continuous), educational level (more than primary school yes/no, dichotomous), LTPA (METs·min/d, continuous) and energy under- and over-reporting (both yes/no, dichotomous). The normality assumption of regression models was assessed by the normal probability plot. Additionally, linear regression models including secular trends in diet quality as the exposure variables and changes in diet cost were fitted.

Substitution models were fitted to analyze changes in diet quality by the effect of replacing the changes in monetary costs of red meat and sausages, fast food and soft drinks, fish, cereals, dairy products, and pastry with the changes in the price of vegetables and fruits. For this purpose, changes in monetary costs of vegetables and fruits were included simultaneously with red meat and sausages, fast food and soft drinks, fish, cereals, dairy products, and pastry in multivariate linear regression models. The difference in the coefficients from these models was used to estimate the effect on changes in diet quality indices of replacing a 1-Euro increase in energy-adjusted diet costs of red meat and sausages, fast food and soft drinks, fish, cereals, dairy products, and pastry with a 1-Euro increase in vegetables and fruits.

Cubic spline analysis was performed to investigate nonlinear associations between changes in the energy-adjusted diet cost and changes in weight and BMI using the 'gam' package in R version 3.0.2. The assumption of normality in the regression models was assessed using the normal probability plot.

To explore effect modification according to sex, we modeled interaction terms for sex/weight change and sex/BMI change. Differences were considered significant if $p < 0{\cdot}05$. Statistical analysis was performed using SPSS version 18.0. (SPSS Inc. Chicago, Ill., USA).

Results

Daily diet cost increased during the follow-up by 35·1% (online Supplementary Table S1). Substantial differences in energy-adjusted diet cost were observed between low and high diet quality at baseline and reexamination (online Supplementary Table S1). No significant effect modification by sex was observed (p>0·1).

In the bivariate analysis, changes in energy-adjusted diet cost were positively associated with the proportion of women, age, BMI, energy consumption, and energy overreporting (online Supplementary Table S2). The opposite was true for energy underreporting.

Differences in the changes observed in food group consumption according to a decrease (1st quintile of changes) and an increase (5th quintile of changes) in energy-adjusted dietary costs are shown in online Supplementary Figure S2. Participants who strongly increased energy-adjusted diet cost increased their consumption of vegetables, fruits, fish, and red meat and sausages and decreased the consumption of pastry, cereal products, soft drinks, and fast food. The opposite was observed for those participants who decreased energy-adjusted diet cost. The strongest effect was seen for vegetables and fruits.

Diet quality increased with increasing energy-adjusted diet cost (Table 1). Changes in the MDS-rec was directly associated with increasing energy-adjusted diet costs, whereas the opposite was found for energy density (Table 1). The latter showed the strongest association with changes in energy-adjusted diet cost.

An increase of 1€ in energy-adjusted diet cost was associated with a decrease of 0·3 kg in body weight and 0·1 kg/m^2 in BMI. These associations were no longer present when the models were adjusted for energy density (Table 2).

Associations between changes in energy-adjusted diet cost and changes in weight and BMI were tested for nonlinearity, but no significant evidence was found (P for curvature of changes in weight and BMI = 0·47 and 0·33, respectively).

Replacing a 1€ increase in the energy-adjusted monetary cost of red meat and sausages, fast food and soft drinks, pastry, and cereals with 1€ increase in vegetables and fruits significantly increased the MDS-rec (Table 3) and decreased energy density.

Discussion

An increase in the energy-adjusted diet cost predicted a shift to a healthier diet and to better weight management. Diet quality strongly increased if money previously spent on unhealthy food choices such as fast food and pastry is instead spent on vegetables and fruits.

A recently published meta-analysis [5] concluded that healthier diets are more expensive than less healthy diets. The authors found a difference of $1·54 per 8·36MJ/day between extreme quintiles of diet quality, defined by a nutrient-based dietary pattern. The monetary cost of a healthy dietary pattern, defined post-hoc by cluster analysis, was twice the price of the least healthy pattern in the UK Women´s Cohort Study[26]. Monsivais and colleagues reported that strong adherence to the Dietary Approaches to Stop Hypertension (DASH) diet was 0·78$/8·36MJ more expensive than low adherence to this dietary pattern[27]. In the present study, the energy-adjusted diet cost for high diet quality was 2·95€ ($3·33) per day higher than low diet quality; this amounts to 1076€ ($1215) per year for one person who chooses high diet quality. One might hypothesize that this would negatively influence healthy food choices, particularly in low income families.

We used two conceptually different indices to measure overall diet quality: food-based and energy density, which we have shown to be a good indicator of diet quality in the present population[9,10]. Our prospective results indicate that reducing diet cost has detrimental effects on diet quality. This was true for both indicators of diet quality, underlining the robustness of our data.

In the present study, an increase in energy-adjusted diet cost of 1€ represented a 54·5% difference between the second and fourth quintile in energy-adjusted diet cost changes. The change from a strong decrease to a strong increase in diet quality measured by adherence to the Mediterranean diet and energy density was associated with an increase of 0·42€ and 1·98€ in the energy-adjusted diet cost, respectively. For both diet quality scores, the percentage difference and percentage increase in energy-adjusted diet cost between the strong decrease and strong increase was 133% and 400%, respectively..

The price of healthy foods increased to a greater extent than that of less healthy foods in Spain between 2000 and 2010[8], and price is an important determinant for food choices[4]. Individuals and families facing economic constraints may be especially likely to reduce their consumption of more expensive foods, regardless of their contribution to diet quality. Additionally, it is not surprising that a strong decrease in diet cost in the present study was concomitant with a dramatic decrease in the consumption of fruits and vegetables.

On the other hand, fast food and soft drinks consumption increased in participants who greatly reduced their diet cost. This is of particular concern because soft drink and fast food consumption are associated with less healthy dietary patterns and weight management in the present population [28]. Moreover, low diet quality is responsible for 17% of disability-adjusted life years in the United States[29]. Low consumption of fruits and vegetables is one characteristic of this low diet quality. Our substitution models convincingly show the positive effect on diet quality of replacing 1€ ($0·86) increments of dietary costs in pastry and soft drinks and fast food with 1€ increases in fruits and vegetables. These data underline the paramount role of fruit and vegetable consumption in a healthy diet. Moreover, our data raise the question of food price intervention using tax policy and subsidies. Evidence indicates that a rise in prices of unhealthy foods and a price reduction for healthier alternatives improve overall diet quality[4,30,31].

Following the Mediterranean dietary pattern and low energy-dense diets have been frequently associated with better weight management and reduced risk of obesity[11,18,32]. Therefore, and based on the present results, we hypothesized that changes in diet cost would affect body weight. Our analysis showed a direct relationship between a decrease in diet cost and weight gain. This association was mainly explained by diet quality; adjusting for changes in diet quality strongly attenuated the impact of increased diet cost on weight gain.

This study has both limitations and strengths. Due to the nature of observational studies, causal relationships cannot be drawn. Furthermore, all the dietary instruments that measure past food intake are vulnerable to random and systematic measurement errors. Although the 10-year loss to follow-up of 19·7% in the present study can be considered acceptable, there was some evidence of selection bias among the participants who completed the follow-up, in that they were generally younger and more likely to be female. Variation of monetary cost of food due to regions, seasons, and types of establishment where the food was purchased is a potential bias for the analysis of the impact of diet cost on diet quality. In the present study we used yearly averages of food prices across multiple regions of Spain, which somewhat reduces this limitation. Furthermore, we do not have data on food consumption away from home. Our analysis is based on the assumption that most foods consumed were prepared at home. Indeed the findings of this study may not hold for those who frequently eat away from home. The strengths of the present study include its population-based design, long-term follow-up, and the availability of body weight and validated lifestyle measurements at baseline and follow-up.

Results of the present study are in line with previous findings showing that healthy diets are considerably more expensive than unhealthy diets. Our prospective evidence indicates that a worsening of overall diet quality and weight development was related to a decrease in diet cost. This finding is of importance for health policy because it underlines the need to promote healthy diets that are accessible for all income levels, with implications for food pricing, agricultural and consumer subsidy programs, and tax policies.

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Conflict of interest

The authors declare that there are no conflicts of interest.

Authorship

H.S., L.S.M, and R.E., designed the research; H.S., L.S.M., I.S., M.I.P., M.F. and R.E. conducted the research; H.S. and I.S. analysed the data; and H.S. wrote the manuscript and had primary responsibility for the final content. All authors read and approved the final manuscript.

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Supplementary Figure S1. Flow chart

Supplementary Figure S2. Sex and age adjusted changes in food consumption (g/4.18MJ) according to extremes (1st versus 5th quintile) of changes in energy-adjsuted diet cost. Sex, age, and Bonferroni adjusted pairwise comparison of means. P< 0·05 for all differences.

Table 1. Association between changes in monetary diet cost and changes in adherence to modified Mediterranean diet score recommended intake and energy density.

	Model 1		Model 2	
	β (95% CI)*	*p*	*β* (95% CI)*	*p*
Scores				
- *Continuous*				
Δ MDS-rec†	0·024 (0·007;0·041)	0·006	0·042 (0·025;0·0.060)	<0·001
Δ Energy density ‡	-1·591 (-1·703;-1·479)	<0·001	-1·586 (-1·699;-1·473)	<0·001
- *Quintiles*				
Δ MDS-rec†	0·049 (0·013;0·084)	0·007	0·083 (0·046;0·199)	<0·001
Δ Energy density ‡	-0·396 (-0·425;-0·367)	<0·001	-0·393 (-0·422;-0·29)	<0·001
Standardized scores§				
Δ MDS-rec†	0·067 (0·019;0·115)	0·006	0·118 (0·069;0·167)	<0·001
Δ Energy density ‡	-0·580 (-0·621;-0·539)	<0·001	-0·578 (-0·620;-0·537)	<0·001

MDS-rec, modified Mediterranean diet score recommended intake

* Linear regression analysis *β* coefficients reflect changes in energy adjusted diet cost per 1 unit increase in continuous diet quality scores and per 1 quintile increase in categorical diet quality scores.

† Changes in the MDS-rec

‡ Scores were standardized as a Z-value

§ Changes in energy density

Model 1: adjusted for sex (men/women; dichotomous), age (years; continuous), and baseline energy adjusted- diet cost. Model 2: model 1 plus baseline data of smoking (yes/no; dichotomous), energy intake (MJ; continuous), educational level (more than primary school, yes/no; dichotomous), leisure-time physical activity (METs·min/d; continuous), and energy under- and over-reporting (both yes/no; both dichotomous).

Table 2. Association between changes in energy-adjusted diet cost and changes in body weight and body mass index. *

	Model 1		*Model 2*		*Model 3*	
	β (95% CI)	*p*	*β* (95% CI)	*p*	*β* (95% CI)	*p*
Δ Weight (kg)†	-0·30 (-0·53;-0·07)	0·01	-0·29 (-0·52;-0·07)	0·02	-0·10 (-0·38;0·19)	0·51
Δ BMI (kg/m^2)‡	-0·10 (-0·19;-0·01)	0·03	-0·10 (-0·18;-0·01)	0·04	0·00 (-0·11;0·10)	0·99

BMI, body mass index; LTPA leisure-time physical activity; Mets, metabolic equivalents

* Multiple linear regression analysis. *β* coefficients reflect changes in body weight and BMI per 1 €/8·36MJ l increase in diet cost.

† Changes in body weight

‡ Changes in BMI

Model 1: adjusted for sex (men/women; dichotomous), age (years; continuous), and baseline scores.

Model 2: includes additionally baseline data of smoking (yes/no; dichotomous), energy intake (MJ; continuous), educational level (more than primary school yes/no; dichotomous), LTPA (METs·min/d; continuous), and energy under- and over-reporting (both yes/no; dichotomous).

Model 3: includes additionally Δ energy density (continuous).

Table 3. Association between 10-year changes in diet quality and replacement of 1€/8·36 MJ increased consumption of fast food and soft drinks, pastry, red meat and sausages, fish and seafood, cereals, and dairy products, with 1€/8·36 MJ increase in fruits and vegetables.*

	MDS-rec β (95% CI)	Energy density β (95% CI)
Fast food and soft drinks	2·98 (1·58;4·37)	-0·36 (-0·533;-0·187)
Pastry	3·94 (1·08;6·81)	-1·32 (-1·67;-0·97)
Red meat and sausages	1·33 (1·04;1·61)	-0·12 (-0·15;-0·08)
Fish and seafood	-0·28 (-0·73;0·17)	-0·01 (-0·04;0·02)
Cereals	0·47 (0·15;0·79)	-0·21 (-0·25;-0·17)
Dairy products	-0·79 (-1·15;-0·35)	0·02 (-0·03;0·07)

MDS-rec, modified Mediterranean diet score recommended intake; NDS, nutrient density score; DQI-R, diet quality index

*Linear regression analysis adjusted for sex (men/women; dichotomous), age (years; continuous), and baseline data of smoking (yes/no; dichotomous), energy intake (MJ; continuous), educational level (more than primary school yes/no; dichotomous), leisure-time physical activity (METs·min/d; continuous), and energy under- and over-reporting (both yes/no; dichotomous). β coefficients reflect changes in diet quality scores of replacement of 1€/8·36MJ increased consumption of fast food and soft drinks, pastry, red meat and sausages, fish and seafood, cereals, and dairy products with 1€/8·36MJ increase in fruits and vegetables.

Online Supplement

Table S1. Diet cost

	2000		2009/10
Diet cost (€)	4·83±1·99		6·39±2·65
- Mean difference (€)		1·55	
- Mean difference (%)		27·8	
Diet cost (€)/8·36MJ	3·68±0·89		4·97±1·16
- Mean difference (€)		1·28	
- Mean difference (%)		29·8	
Diet cost/8·36MJ			
low vs· high diet quality*			
MED-rec	3·37±0·87/4·03±0·91		4·58±1·11/5·40±1·11
- Mean difference (€)	0·66		0·82
- Mean difference (%)	17·8		16·4
Energy density	2·89±0·53/4·69±0·92		3·87±0·65/6·29±1·26
- Mean difference (€)	1·80		2·42
- Mean difference (%)	47·5		47·6

MDS-rec, modified Mediterranean diet recommender intake

* MED-rec = 1st vs 5th quintile; energy density = 5th vs 1st quintile.

Table S2. Baseline characteristics of participants according quintiles of changes in energy adjusted-diet cost (€/8.36MJ/d)*

	1 (n=423)		2 (n=422)		3 (n=423)		4 (n=422)		5 (n=422)		*P* trend†
Mean (range)	-0·06	(-0·35;0·23)	0·36	(0·24;0·50)	0·62	(0·51;0·73)	0.86	(0.74;;10.2)	1.42	(1.02;6.79)	-
Baseline diet cost (€)	5.1 (3.6;6.1)		4.8 (3.6;5.7)		5.0 (3.7;5.8)		4.6 (3.4;5.5)		4.7 (3.4;5.6)		0.001
Women (%)	52·0		49·0		49·8		53·4		59·2		0·019
Age (years)	49·8	(48·6;51·1)	47·5	(46·3;48·8)	48·2	(47·0;49·5)	49·0	(47·8;50·3)	51·2	(50·0;52·4)	<0·001
Smokers‡ (%)	27·0		26·3		27·0		26·1		22·7		0·07
Educational level§ (%)	35·7		40·0		38·2		37·3		32·0		0·17
LTPA (METs·min^{-1} ·d^{-1})	203	(97;365)	187	(91;342)	202	(106;355)	198	(104;338)	209	(109;350)	0·60
Weight (kg)	71·8	(70·5;73·1)	72·8	(71·4;74·1)	72·6	(71·3;73·9)	72·7	(71·4;74·0)	73·4	(72·1;74·7)	0·15
BMI (kg/m^2)	27·0	(26·6;27·4)	26·9	(26·5;27·3)	27·0	(26·5;27·4)	27·2	(26·8;27·6)	27·8	(27·4;28·3)	0·006
Energy consumption (MJ)	10·2	(9·8;10·6)	10·9	(10·6;11·4)	11·7	(11·3;12·1)	11·1	(10·7;11·5)	11·7	(11·3;12·1)	<0·001
Energy underreported (%)	33·3		22·5		16·8		22·3		22·7		0·001
Energy overreporter (%)	8·3		10·3		13·7		11·9		14·6		0·003

LTPA, leisure-time physical activity; METs, metabolic equivalents; BMI, body mass index

Table continues

Table continued

*Values are expressed as means and 95% confidence interval, proportions, and median and interquartile range and computed using general linear models.

†p values were obtained by ANOVA, Kruskal Wallis, and Pearson chi-square for normal continuous, non-normal continuous, and categorical variables, respectively.

†Active smokers or ex-smokers less than 1 year.

§ More than secondary school education.

Figure S1. Flow chart of the study participants

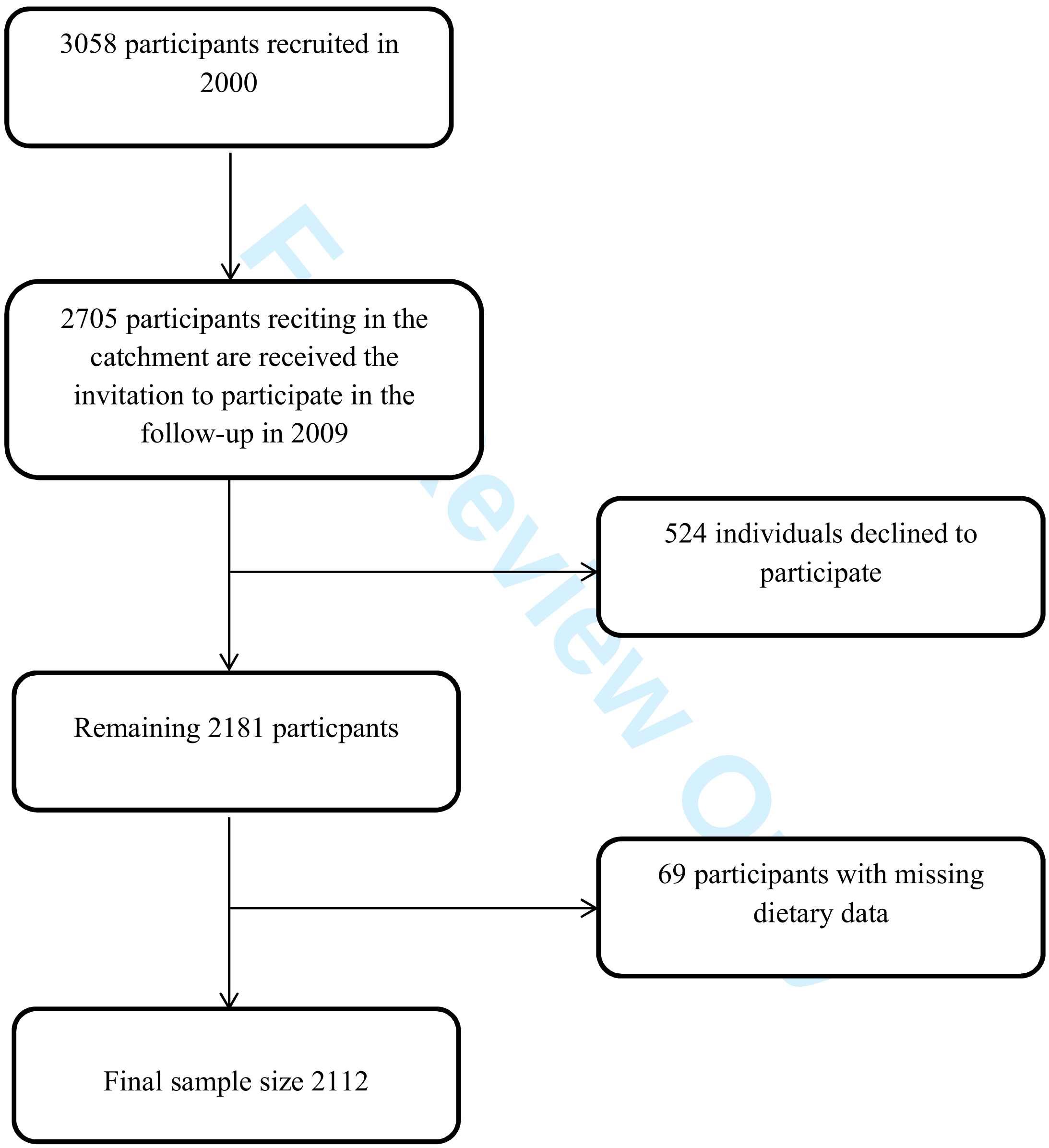
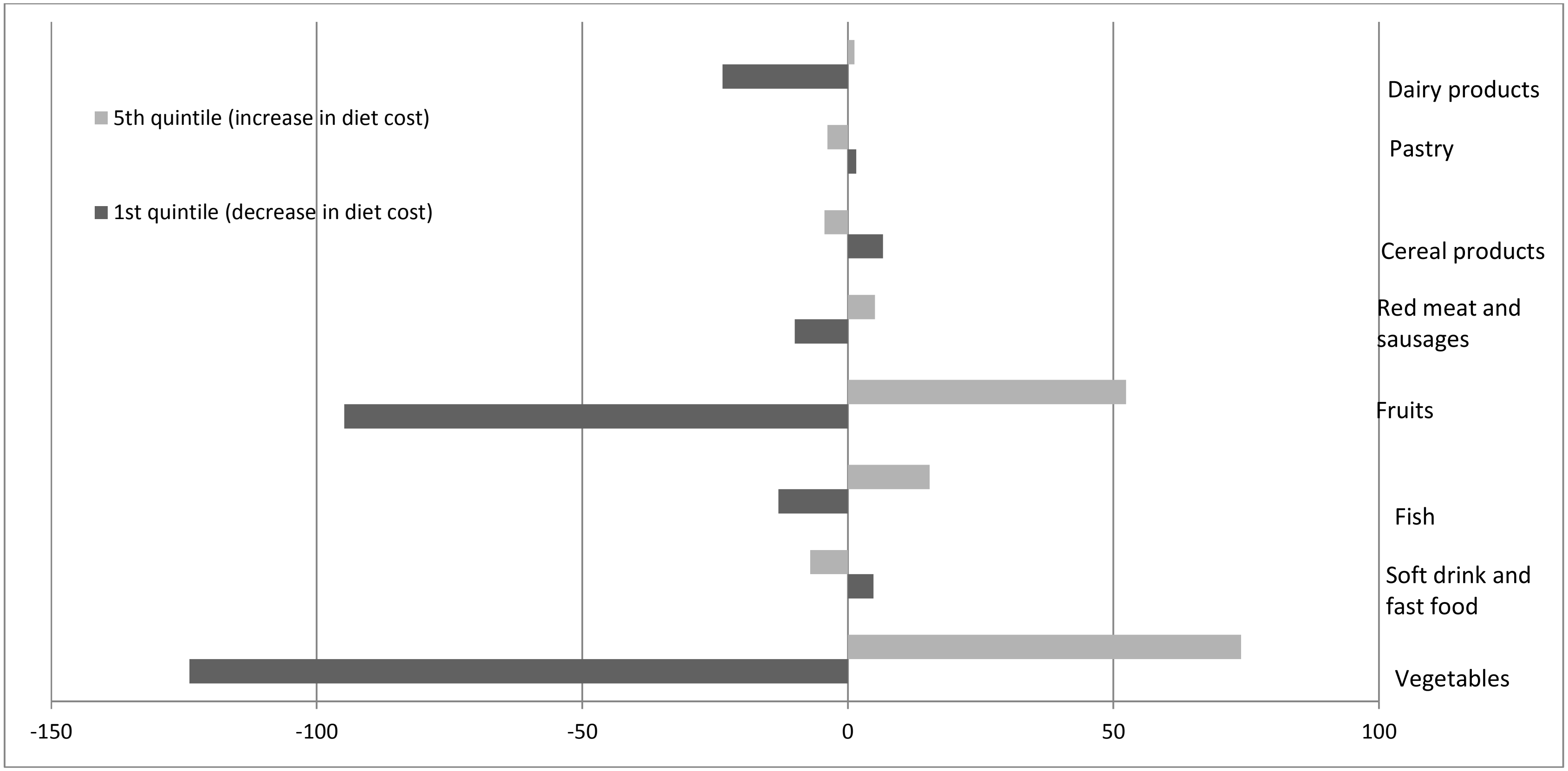


Figure S2 Sex and age adjusted changes in food consumption (g/4.18MJ) according to extremes (1st versus 5th quintile) of changes in monetary diet cost.



Sex, age, and Bonferroni adjusted pairwise comparison of means. $P < 0 \cdot 05$ for all differences.