Low-fat, light, and reduced in calories:
Do these claims really lead to an increase in consumption?

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0. Abstract

Recent experimental research has shown that light, low-fat and other claims that signal low calorie content can increase consumption and hence can be counter-effective. In this article we use detailed data from the Dutch National Food Consumption survey to determine the extent to which this increase in consumption can also occur outside an experimental setting. We investigate consumption of 36 different products, including dairy products, fats, and non-alcoholic beverages. Looking at both the consumption amount in grams per eating occasion and the consumption frequency over a period of two days, we find almost no evidence that more is consumed of "light" variants than of regular variants. For only 5 of the 36 products we find a consistent and significant higher consumption in grams of the "light" variant, while for 8 products, consumption frequency of the "light" variant is significantly higher. Moreover, for almost all of these products, we observe that in terms of calories, still less is consumed of the "light" variant than of the regular variant. We conclude that in real-life non-experimental settings "light" claims do not lead to increased consumption of the "light" products.

Keywords: nutrition claims, light, low-fat, food intake, consumption volume, consumption frequency, energy intake

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1. Introduction

Common sense tells us it is wise to choose a light or low-fat version of a product instead of the regular version, when dieting or trying to maintain weight. Unexpectedly, recent experimental research has shown that this might not be such a good idea. The presence of a light claim or of another packaging cue that signals that this product is low in fat, calories or sugar, can apparently lead to a significant increase in consumption (Cavanagh and Forestell, 2013; Provencher et al, 2009; Shide and Rolls, 1995; Wansink and Chandon, 2006). Wansink and Chandon (2006) even found that, under certain circumstances, the intake increases so much due to the low-fat label that more calories are consumed when eating a low-fat variant than when eating a regular variant. This finding is of course quite worrisome, in particular as Johansen et al (2011) show that the reduced fat content is one of the most important reasons to choose a low-fat variant. So, people who think they do the right thing by choosing a low-fat variant might actually be doing the wrong thing and would be better off by choosing the regular variant.

The aim of our paper is to examine to what extent such worrying increased consumption found in experiments also occurs outside an experimental setting. Note that when we refer to "light" products, we refer to all products with a reduced fat, sugar or calorie content. Experiments can be set up in such a way that the only difference between the "light" and the regular variant is the label. In real life, however, there will always be more differences between a "light" and a regular product, like the taste or the price. Therefore the effect that "light" labels have on consumption might not be as strong in the real world as it is in an experimental setting, and this motivates our study below.

Using extensive data from the Dutch National Food Consumption Survey we examine the consumption amount of the regular and reduced fat/calorie/sugar variants of 36 food types. The main result is that for the majority of the foods we actually find no difference in consumption of the "light" and the regular variant. Only for a few products we obtain evidence that people consume more of the "light" than of the regular variant. When we do find an increase in consumption, we find it to be small. In the end, people consume lesser calories when choosing the "light" variant while even consuming more than when they choose the "regular" variant and consume less. Our main conclusion is thus that there is little reason to worry about the "consumption increasing" effects that "light" claims were suggested to have.

2. Literature

The physiological impact of foods reduced in fat, sugar or calories on consumption

Nutrition researchers have for a long time tried to determine how foods that are reduced in sugar or fat impact feelings of hunger, satiation, bodyweight, and energy intake during and after the consumption of the modified food. Mattes and Popkin (2009) estimated that about 11% of the US population consumes beverages with artificial sweeteners and that around 6% consumes foods with artificial sweeteners. Artificial sweeteners have been accused of having appetite enhancing qualities (Blundell and Hill, 1986; Tordoff and Alleva, 1990), but in more recent research no support has been found for this claim (Bellisle and Drewnowski, 2007; Mattes and Popkin, 2009; Rolls et al, 1989; Anderson et al, 1989). Another concern is that users of artificial sweeteners will compensate for the missing energy (Bellisle and Perez, 1994). Although there are some studies that support this (for example, Lavin et al, 1997), Mattes and Popkin (2009) showed in their review that many other studies have not found that the use of artificial sweeteners leads to complete energy compensation.

The relation between artificial sweeteners and BMI has also gained considerable attention. Bellisle et al (2001) find that users of artificial sweeteners have a higher BMI and waist/hip ratio than non-users. It should however be taken into account that their conclusion is based on cross-sectional data and that the direction of causality might be unclear. Indeed, longitudinal studies found mixed results. For example, Fowler et al (2008) found that over a 9-year period an increase in the use of artificial sweeteners is significantly related to increases in BMI. In contrast, Colditz et al (1990) found that increased intake of soda with artificial sweeteners led to a lower weight gain than decreased intake of soda with artificial sweeteners. Taken together still little seems to be known about the relation between BMI and consumption of artificial sweeteners (Pereira, 2013).

According to Benton (2005) fats might play a much more important role in the development of obesity than sugars do, which suggests the relevance of products that are reduced in fat. Bellisle et al (2001) examine the body size and micronutrient intake of users and non-users of low-fat products. They find that female users of low-fat products were somewhat heavier than the non-users, while male users had a similar weight than non-using males. Mela (1997) concludes in his review that short-term weight loss and reduced fat intake occur when full-fat variants are substituted by low-fat variants. In the longer term however, energy compensation is likely to occur. This is confirmed by a number of intervention studies in which use of reduced fat products instead of full-fat products does not lead to reduced energy intake or weight loss (Gatenby et al, 1997; Hendrie and Golley, 2011; Lawton et al, 1998). In contrast, Peterson et al (1999) show with US-based actual intake data that users of fat-reduced products have both a lower fat and energy intake as compared to non-users. Kendall et al (1991) find that in a 7-week period, a low-fat diet leads to weight loss as compared to a full-fat diet. Some energy compensation does take place, but not enough to fully

offset the lower amount of energy consumed from fat. A reduced fat diet also leads to considerable weight loss in a 1-year intervention study by Ello-Marin et al (2007). It should however be noted that in this study participants also received advice about appropriate portion sizes, meal and snack ideas, and so on.

In sum, there is evidence that there is a compensation of at least part of the reduction in energy intake that is brought about by consumption of reduced sugar and reduced fat foods. Following this evidence, it is thus possible that more is consumed of "light" products than of regular products. However, whether this increase in consumption is sufficient to compensate for the lower calorie / fat content of "light" products is open for discussion. Furthermore, energy compensation might also take place by consuming more of other food items and not necessarily by consuming more of the "light" food.

The psychological impact of foods reduced in fat, sugar or calories

One of the first studies to show that low-fat labels can impact consumption is the study of Shide and Rolls (1995). When subjects received a preload of low-fat, high-calorie yoghurt labelled as low on fat, they consumed more during lunch than when they received a high-fat, high-calorie yoghurt labelled as high on fat. When subjects received the same yoghurt without labels subjects in the high-fat, high-calorie yoghurt condition ate more during lunch than those in the low-fat, high-calorie condition.

Using a number of experiments, Wansink and Chandon (2006) showed that people eat more from a snack food when it has a "low-fat" label than when it has a "regular" label. Provencher et al (2009) confirmed these findings. Subjects in their study were invited to taste a new type of oatmeal cookies. The interviewer gave a description of the cookies that either was strongly health focussed or strongly focussed on taste. In the health condition subjects ate about 35% more than subjects in the taste condition. Cavanagh and Forestell (2013) showed that consumption can even be influenced when the brand of the product is associated with either healthy or unhealthy foods. Restrained eaters ate more cookies when they believed the cookies were from a healthy brand than from an unhealthy brand. Fitness cues that are present on the food packaging can have a similar effect (Koenigstorfer et al. 2013). If for example the word fitness is included in the product or brand name (for example "fitness trail mix") significantly more is consumed than when this word is not present.

Not all studies that examine the impact of food labels on intake find significant effects. In a recent study by Ebneter et al (2013) the presence of a low-fat or regular label on M&M's did not significantly influence consumption, but did have an effect on calorie estimates and healthiness perception. Similar findings are reported by Gravel et al (2012). They test three types of labels:

"healthy", "diet", and "hedonic". Consumption did not differ across these conditions, but perceptions of healthiness did.

According to Wansink and Chandon (2006) low-fat claims influence consumption through feelings of guilt. People feel less guilty about eating a low-fat product than about eating a full-fat product (Kivetz and Keinan, 2006) and hence they are less likely to restrain their consumption. Beliefs about the tastiness of the food could potentially counteract the positive effects of guilt-reduction generated by low-fat labels. A number of studies have shown that foods with health labels are expected to be liked less than foods with regular labels (Andrews et al, 1998; Wardle and Solomons, 1994; Liem et al, 2012). Raghunathan et al (2006) show that when an item is perceived as unhealthy, the better the expected taste and the more it is enjoyed during consumption. Following this logic, less should be consumed of foods with reduced fat / sugar / calorie labels than of their regular counterparts.

Combining physiological and psychological research

We must conclude that the evidence that health labels can increase consumption is mixed. It is questionable if in real life, where "light" foods have a different taste, texture and price than their regular counterparts, the psychological effect of the health label is strong enough to lead to an increase in consumption. Nonetheless, when we also consider the physiological impact that reduced energy foods can have on consumption, we hypothesize that

more will be consumed in grams of products that are reduced in fat, sugar or energy than of their regular counterparts.

In the next section we discuss the data that we use to put this hypothesis to an empirical test.

3. Method

Data – Dutch National Food Consumption Survey

The data are taken from the Dutch National Food Consumption survey 2007 – 2010 (DNFCS) conducted by the National Institute for Public Health and the Environment (DNFCS 2007-2010, RIVM). Respondents live in the Netherlands and are between 7 and 69 years old. Pregnant and breastfeeding women are excluded. The data were collected over a three-year period from March 2007 to April 2011. The total sample consists of 3,819 respondents. For this study, we decided to remove the children from the analysis as the eating behaviour of children is strongly influenced by their parents. Furthermore, children might not understand food labels as well as adults do, which

could potentially lead to a different effect of food labels on consumption. Therefore, children of age 16 and younger were removed, leaving a total sample of 2,394, of which 1,193 are males and 1,201 are females. The sample can be regarded as representative of the Dutch population in terms of education, region, and urbanisation. The age distribution is somewhat skewed, with a relative overrepresentation of people younger than 30 years. See Figure 1 for a comparison of the age distribution of the sample with that of the Dutch population in the period 2007-2010 (CBS – Statline). The goal of this study, however, is not to give a representative overview of Dutch eating behaviour, as we aim to compare consumption quantities of regular and "light" variants of products. Hence, we decided not to weigh the data.

The food consumed on two different days in a 4-6 week period was recorded using the EPIC-Soft (IARC) interviewing software. Next to a detailed record of all foods consumed during these two days, the time, place and occasion of each consumption moment was recorded. Also a large number of demographic variables including age, BMI, dietary restrictions, and household size, are available to us. A complete overview of the data collection can be found in van Rossum et al (2011).

Definition of "light"

The food industry has come up with a multitude of ways to tell consumers that their foods contain less fattening ingredients, where they rely on notions as fat-free, skimmed, reduced in fat, no added sugar, sugar-free, low in calories, low cholesterol, light, and so on. In our study we include all foods that are somehow lower in calorie density than their "regular" counterparts. This means that not only products with a light or low-fat label are included, but also foods with other labels, including products like (semi)-skimmed milk, 20+ cheese, light coke, and sweets with less sugar. To qualify a food item to be less fattening, the calorie density defined as the number of calories per 100 grams has to be lower than the calorie density of the regular variant of the food item.

Selection of food categories

To select the foods of which both high and low-calorie dense variants are available, we used the EPIC-Soft group classification and the NEVO-codes of the foods. Within each EPIC-Soft subgroup, all individual food items were studied, and those that had less calorie dense variants were included for further analysis. The selection of the food items was primarily made using the names and associated NEVO-codes. In some cases also the calorie density was used to aid in our classification. This led to an initial selection of 62 food categories. Initially, food categories were kept as specific as possible. For example, if a certain brand of a food item had a different NEVO-code than the other brands of that food item, it was treated as a separate category. Only when too few respondents had consumed

food in that category it was merged with the more general category, or we completely removed it from the analysis.

Within each food category, the variants were classified according to their "light" status. For example, within the milk category, three variants are distinguished, that is, whole, semi-skimmed, and skimmed. When a food category contained no variants or only one variant that was consumed by more than 10 respondents, it was removed from the analysis. When a food category contained no variants or only one variant that was consumed by more than 30 respondents, it was merged with another category if possible. If it could not meaningfully be merged, it was kept separate. An exception to this rule is the fruit juice category. Within this category there are many different brands with separate NEVO-codes. For simplicity and clarity these have all been merged together into one large "fruit juice" category. This procedure resulted in 36 categories ready for analysis.

Types of "light" and "regular" variants

A total of 19 different variants were identified, see Table 1 for an overview. Of the 36 food categories, 17 had 2 variants, 15 had 3 variants, 3 had 4 variants and 1 had 5 variants. If a category had 3 or more variants and one of the variants was consumed by less than 10 respondents, the variant was removed from the category. The following five special cases should also be mentioned. Merging different brands in the yoghurt drink category resulted in a combined "light" variant consisting of "less sugar", "light" and "no added sugar" products. 40+ and 30+ cheese spreads are merged into a single "30+ and 40+" variant. In the category whipped cream and crème fraiche "65%-75% fat" and "30%-50% fat" are merged in a single "30%-75% fat" variant. In the category butter we merged "25% fat" and "30%-50% fat" into a single "25%-50% fat" variant. Finally, the "less sugar" variant of Dubbelfriss was removed from the analysis to be able to merge Dubbelfriss with the other fruit juices. Table 2 gives an overview of all the food categories that are included and the variants in each category.

Consumption quantities

As mentioned, experimental studies show how a "light" label increases consumption during a single consumption episode (Wansink and Chandon, 2006; Provencher et al, 2009; Cavanagh and Forestell , 2013). However, labels could also influence how frequently respondents permit themselves to eat or drink a certain product. In our analysis we will therefore examine the impact of a "light" label on two different dependent variables, that is, consumption quantity per occasion and the frequency of consumption over the course of two days. Although both dependent variables will be included, the

focus will lie on consumption per occasion as this is most directly related to the available experimental research.

4. Statistical analysis

The first part of our analysis consists of one-way ANOVA's to determine if there are any differences in consumption quantities between the variants in each food category. In case a significant difference is found and the category has more than two variants, a post-hoc test using Tukey's HSD is performed to determine which categories differ significantly from each other.

The second part consists of performing OLS regression analyses with the quantity consumed per consumption occasion as the dependent variable. When controlling for the effect of potential other influences on the consumption amount, we aim to get a more accurate picture of the extent to which a "light" label can increase consumption. We included the variables age, gender, BMI, household size, education, food used in recipe, consumption moment, place of consumption, follows diet and follows rule for food. Table 3 gives an overview of these variables and explains why we included them in the regression models.

Not all food categories have enough consumption occasions to justify a regression analysis. In fact, the categories fruit milk and dairy spread are excluded as they both have less than 50 respondents and less than 60 consumption occasions.

5. Results

Consumption amount per consumption occasion

Our focus is on investigating the consumption amount per consumption occasion as this is the unit of analysis that is most often used in experimental papers (Wansink and Chandon, 2006; Provencher et al, 2009; Cavanagh and Forestell , 2013). Figure 2 gives a graphical overview of the consumption amounts in the different food categories. Below, the results will be discussed per NEVO-category. For a detailed overview of all results, please refer to Table 4.

Nuts and peanuts

The only food in this category that had a sufficient amount of "light" users was peanut butter. Neither the direct comparison of the means ($F(1,466)=0.84$, $p=0.36$) nor the OLS regression ($R^2=0.09$, $F(13,453)=3.38$, $p<0.01$) showed significant results ($\beta=-1.88$, $p=0.64$).

Dairy

The consumption quantity of whole ($M=216.95$, $SD=154.66$), semi-skimmed ($M=190.39$, $SD=140.45$) and skimmed milk ($M=227.49$, $SD=172.83$) differs significantly, $F(2,3619)=9.38$, $p<0.01$. A post-hoc Tukey HSD test shows that consumers drink significantly less of semi-skimmed milk than of whole milk ($p=0.01$), and that they drink significantly more of skimmed milk than of semi-skimmed milk ($p<0.01$). The difference between skimmed and whole milk is not significant ($p=0.73$). When we look at the OLS regression results, the picture is a little different ($R^2=0.35$, $F(16,3605)=120.66$, $p<0.01$). When controlling for other variables that can impact consumption quantity, the consumption amount of semi-skimmed milk does not differ significantly from that of whole milk ($\beta=-2.92$, $p=0.71$). The consumption amount of skimmed milk is however significantly higher than that of whole milk ($\beta=27.43$, $p=0.02$). Taken together, these findings thus provide some evidence that more is consumed from skimmed milk than from the whole and semi-skimmed variant.

The next category for which we find a significant difference is chocolate milk, although it is opposite to what is hypothesized. The OLS regression ($R^2=0.13$, $F(15,219)=2.14$, $p<0.01$) shows that significantly less is consumed of light than of regular chocolate milk ($\beta=-45.07$, $p=0.02$). Comparison of the means using ANOVA does not yield significant results, $F(2,232)=1.88$, $p=0.16$, but qualitatively, the results are the same. Mean consumption of regular, semi-skimmed and light chocolate milk is respectively $M=249.57$ ($SD=88.66$), $M=245.18$ ($SD=108.36$), $M=217.13$ ($SD=79.01$).

The OLS regression for yoghurt drink ($R^2=0.09$, $F(14,537)=3.57$, $p<0.01$) shows that consumption significantly increases when a "light" variant such as no added sugar or less sugar is consumed instead of the regular variant ($\beta=21.63$, $p=0.04$). This result is directionally supported by the ANOVA results, $F(1,552)=3.85$, $p=0.05$.

We see large differences in consumption of fromage frais (fresh cheese) with fruit flavour. Consumption of the regular variant is $M=127.21$ ($SD=67.91$), the semi-skimmed variant is $M=170.02$ ($SD=83.25$), and the skimmed variant is $M=231.99$ ($SD=96.74$). The ANOVA shows that these differences are statistically significant, $F(2,100)=8.20$, $p=<0.01$, although a post hoc Tukey HSD test shows that only the difference between regular and skimmed ($p<0.01$) and the difference between skimmed and semi-skimmed ($p<0.01$) is significant. These results are confirmed by the regression analysis ($R^2=0.30$, $F(15,87)=2.54$, $p<0.01$). Keeping everything else equal, the regression shows that

the skimmed variant increases consumption by 70 grams compared to the regular variant (β=69.67, p=0.02).

In the hard cheese category, the consumption of the 45+ variant (M=32.80, SD=22.67), the 30+ variant (M=29.26, SD=16.48), and the 20+ variant (M=27.53, SD=19.37) is in the opposite direction as hypothesized, F(2,3698)=7.62, p<0.01). A Tukey HSD post-hoc test shows that only the difference between 45+ and 30+ is significant (p<0.01). These findings are supported by the regression analysis (R^2=0.04, F(16,3680)=11.11, p<0.01) only in terms of the sign of effects, that is, the regression coefficients of 30+ cheese is β=-1.34 (p=0.22) and of 20+ cheese is β=-2.02 (p=0.40).

The last food item in the dairy category for which we find a significant effect is the combined category whipped cream and crème fraîche. The regression (R^2=0.20, F(15,185)=3.15, p<0.01) shows a decrease in consumption when a reduced fat variant is chosen instead of the full fat variant, β=-14.44, p=0.03. These results are directionally supported by the ANOVA analysis, F(1,200)=0.48, p=0.49, with a mean consumption of M=25.09 (SD=35.17) of the regular variant, and of M=20.80 (SD=24.76) of the less fat variant.

As can be seen in Table 4, there are also some foods in the dairy category for which none of the differences are significant, and these are fruit milk, plain yoghurt, fruit yoghurt, cheese spread, dairy spread, custard, and coffee creamer. In sum, we thus have 7 categories within the dairy category for which we do not find any effects, 3 for which we find an effect that is opposite to what we hypothesized (chocolate milk, hard cheese, and crème fraîche – whipped cream), and 3 for which the effect is in the hypothesized direction (milk, yoghurt drink, fromage frais fruit). Overall, there is thus little evidence that a light claim increases consumption.

What is interesting is that the categories for which the light claim increases consumption are generally considered healthier / less fattening than those for which the light claim decreases consumption. It is possible that for fattening categories, a preference for the light variant might not be deemed as sufficient to control weight and the consumption amount itself is reduced as well. For categories that are less fattening, the light variant might be regarded as sufficient to avoid weight gain.

Cereal products

For both crisp bread and potato chips the ANOVA is not significant, F(2,330)=1.06, p=0.35, and F(2,586)=0.36, p=0.70 respectively, neither are any of the β's for the light and healthy variant in the regression models.

Fats

For butter, only the OLS regression shows a significant result (R^2=0.08, F(14,968)=6.01, p<0.01). Compared to the full-fat category, less is consumed of variants that vary between 25% and 50% less fat (β=-1.89, p=0.03), which is thus contrary to what we hypothesized.

Margarine has a large number of different variants that differ in calorie density. An ANOVA analysis shows that consumption amounts vary significantly across these variants, F(4,5457)=10.63, p<0.01. In ascending order of calorie density, the mean consumption in each of the conditions is: M=9.69 (SD=7.95) for full-fat, M=13.33 (SD=9.89) for 65-75% fat, M=11.74 (SD=8.27) for 30-50% fat, M=11.94 (SD=8.66) for low fat and M=11.07 (SD=7.66) for light. A Tukey HSD post-hoc test shows that the consumption of full-fat margarine is significantly lower than consumption of all reduced fat variants (p<0.02), which is as expected. However, what is unexpected is that the consumption of 65-75% fat margarine is significantly higher than that of light margarine (p=0.02). In the regression (R^2=0.12, F(18,5444)=41.08, p<0.01), the amount consumed of the 65-75% fat variant is significantly higher than of the full-fat variant (β=2.33, p<0.01). Also the consumption of the low fat variant is significantly higher than that of the full-fat variant (β=0.92, p=0.03). The β's of 30-50% fat and light are not significant, β=0.96, p=0.06, and β=0.32, p=0.48 respectively. Overall, the emerging pattern seems to show that people reduce consumption of a full fat product, and that different degrees of reduced fat do not impact consumption amounts.

"AH Bewust" is a specific variant of margarine, and its consumption pattern is opposite to what we found for the general margarine category. More is consumed of the 30-50% fat variant than of the light variant, F(1,192)=10.83, p<0.01. These results are confirmed by the regression analysis (R^2=0.30, F(13,180)=5.96, p<0.01), as compared to the 30-50% fat variant, the light variant decreases consumption by β=-2.67, p=0.02.

The results for cooking fat are again in the expected direction. People use on average 5.84 grams (SD=6.76) of the full-fat variant, 7.55 grams (SD=7.12) of the 65-75% fat variant, and 7.50 grams (SD=7.06) of the light variant, F(2,1425)=9.82, p<0.01. Quite surprisingly, the OLS regression (R^2=0.07, F(16,1410)=6.71, p<0.01) shows that only consumption of the 65-75% fat variant is significantly higher than that of the full-fat variant (β=1.33, p<0.01). The coefficient for the light variant is not significant (β=1.31, p=0.16).

The results in the fats category are mixed. For margarine and cooking fats a pattern emerges that seems to indicate that people reduce consumption of full-fat variants. People do not seem to differentiate between light variants with varying degrees of fat percentage. Furthermore, these results do not hold for all products in the fats category. For butter and the margarine product "AH Bewust", we find the exact opposite pattern, with more being consumed of the full-fat variant than the "light" variant.

Sugar and confectionary

For jam, chewing gum and boiled sweets, consumption of the less sugar variant is consistently lower than consumption of the regular variant. Mean consumption of the regular and less sugar variant of jam is M=28.57 (SD=16.88) and M=23.31 (SD=18.26), $F(1,768)=13.13$, $p<0.01$, respectively. For chewing gum these values are M=5.92 (SD=9.65) and M=1.95 (SD=1.41), $F(1, 624)=69.99$, $p<0.01$. And for boiled sweets these values are M=14.48 (SD=26.57) and M=3.42 (SD=2.88), $F(1,294)=10.16$, $p<0.01$. For jam and chewing gum these results are confirmed by the regression analysis (jam: $R^2=0.06$, $F(15,751)=3.41$, $p<0.01$ / chewing gum: $R^2=0.15$, $F(14,611)=7.92$, $p<0.01$), with $\beta=-4.13$ ($p<0.01$) for jam and $\beta=-4.33$ ($p<0.01$) for chewing gum. For boiled sweets the regression results ($R^2=0.11$, $F(14,281)=2.51$, $p<0.01$) are marginally significant ($\beta=-7.58$, $p=0.05$).

For the last food item in this category, that is, syrups, none of the differences are significant. Confectionary that is reduced in sugar clearly does not lead to an increase in consumption. It seems that less sugar candies are consumed by people who limit their intake of sugar by both consuming less candies and choosing the reduced sugar variant.

Cakes

Apple pie and cake be made with dairy butter or with a lower fat substitute. The majority of respondents (91%) in the DNFCS data consume the latter variant. The ANOVA gives some directional evidence that people limit their consumption when they choose the dairy butter variant, but the effect is not significant. Of the dairy butter variant 53.66 grams (SD=30.89) is consumed, while this is 69.57 grams (SD=45.53) of the variant without dairy butter, $F(1,322)=3.39$, $p=0.07$. The regression results ($R^2=0.07$, $F(14,309)=1.61$, $p=0.07$) are not significant either ($\beta=-15.27$, $p=0.08$). For croissants both the ANOVA and OLS regression do not show any significant differences.

Non-alcoholic beverages

In this category only two drinks show significant differences in consumption. The consumption amount of non-caffeinated soft drinks, ice tea, and coke does not differ.

The drinks category juice drink includes drink such as Fanta. Significantly more is consumed of the light variants (M=270.08, SD=109.68) than the regular variants (M=249.69, SD=107.29), $F(1,666)=4.21$, $p=0.04$. This is confirmed by a marginally significant effect in the regression analysis ($R^2=0.06$, $F(13,652)=3.07$, $p<0.01$). Compared to the regular variants, light variants increase consumption by $\beta=20.82$ ($p=0.06$).

We find a similar effect for fruit juices. Significantly more is consumed of light juice drinks (M=250.94, SD=107.94) than of regular soft drinks (M=235.80, SD=101.16), F(1,1651)=6.25, p=0.01. The OLS regression (R^2=0.04, F(15,1636)=4.70, p<0.01) confirms these findings with a marginally significant effect of light of β=11.90 (p=0.05).

In sum, for the non-alcoholic beverages there is some evidence that consumption is higher for light than for regular variants. However, it should be kept in mind that of the five drinks in this category, only two showed significant differences.

Condiments and sauces

In the categories gravy powder and gravy we only see a small significant effect in the regression for gravy (R^2=0.07, F(16,523)=2.45, p<0.01). Compared to 65-75% fat gravy, significantly more is consumed of 30-50% fat gravy, β=4.67, p=0.04.

The only other food item in this category that shows significant differences is salad dressing. The pattern of consumption across the regular and different light variants is however a little confusing. Consumption of the full fat variant is 18.00 grams (SD=18.58), of the 25% fat variant is 22.24 grams (SD=20.32), of the 50% fat variant is 17.25 grams (SD=12.90), and of the low-fat variant is 10.97 grams (SD=7.56). The ANOVA shows that the differences are significant, F(3,589)=4.55, p<0.01, however the post-hoc Tukey HSD test shows that only two variants differ significantly, namely 25% fat and low fat (p=0.01). When we look at the regression results (R^2=0.08, F(17,575)=2.96, p<0.01), two light variants show significant results. For the 25% fat dressing β=3.93 (p=0.04), and for the low fat dressing β=-9.78 (p=0.02). So, again, quite conflicting results with no clear pattern.

Taken together, in the condiments and sauces category, there is very little evidence that a variant that is lower in fat, increases consumption.

Summary of results consumption amount per occasion

When we take all results together, we see the following pattern. We did a one-way ANOVA for 36 different food categories. In 6 of these categories, consumption of the light variant(s) was significantly higher than consumption of the regular variant (yoghurt drink, fromage frais fruit flavour, margarine, cooking fat, juice drink, and fruit juices). In 5 of these categories, the effect was opposite to what was expected, that is, consumption of the light variant(s) was significantly lower than of the regular variant (hard cheese, AH Bewust margarine, jam, chewing gum, boiled sweets). For 2 categories, milk and salad dressing, the results were mixed. The OLS regression analyses of 34 categories show a similar pattern. Consumption of the light variant(s) is significantly higher than

consumption of the regular variant in 6 categories (milk, yoghurt drink, fromage frais fruit flavour, margarine, cooking fat, and gravy). The effect is opposite in 6 categories (chocolate milk, whipped cream / crème fraîche, butter, "AH Bewust" margarine, jam, and chewing gum) and mixed in the salad dressing category.

Evidence that light claims can increase consumption during one consumption occasion is thus scarce. In the dairy category, the result that light yoghurt drink and skimmed milk increase consumption is most compelling. Although the effects for fromage frais with fruit flavour are strong, it is consumed by only a limited number of respondents. The effects could partly be caused by high fat versions being available in smaller packages than the low-fat versions. The only other category in which both the ANOVAs and OLS regression provide significant evidence that light claims increase consumption is the fats category. This is however a unique category, as consumers have developed a very negative attitude toward products that obviously have a very high fat content (Schwartz and Borra, 1997). They might thus mainly be limiting consumption of full-fat variants instead of increasing consumption of light variants. Lastly, the fruit drinks and fruit juices show some evidence that more is consumed of the light variant than of the regular variant, although the effects are only marginally significant in the regression.

Overall, the consumption enhancing properties of light claims are thus mostly visible in a small subset of drinks and fats and not in other food items.

Other influences on consumption amount per occasion

The OLS regressions give more insight than just whether or not the light variants significantly influence the consumption amount per consumption occasion. They also provide some insight into how the control variables like gender and BMI influence consumption. Table 6 provides an overview of all the significant β-coefficients ($p<0.05$) in the OLS regressions for the 34 categories. We will shortly comment on the variables that are significant in 10 or more categories.

The variable which most often significantly influences consumption is gender. In all 23 categories, women eat less than men.

Age is significant in 16 categories. As people grow older they need less energy and hence consume less. Quite surprisingly, the amount of chewing gum consumed per consumption occasion increases with age.

Whether the food is consumed as a snack or as part of the main meal, is significant in 15 of the categories. In almost all categories, less is consumed of the food when it is a snack then when it is part of the main meal. The only exception is plain yoghurt.

Household size is significant in 12 of the categories. In each of the 12 categories we see that consumption decreases when household size increases. This is quite an interesting finding as it suggests that people select smaller portions when the food needs to be divided over a larger number of persons.

Lastly, three variables are significant in 10 of the 34 categories. Consumption is higher when the food is consumed directly instead of being used as an ingredient in a recipe, except for hard cheese. In 6 of the 10 categories, consuming the food at work or at school increases consumption compared to consuming it at home. Especially drinks are consumed in higher quantities when at work or school than when at home. Having a higher education significantly decreases consumption in 10 categories, among which milk, hard cheese, potato chips, and dressings.

Consumption frequency in a period of 2 non-consecutive days

As the DNFC survey extends over a period of 2 days, we can also have a look at the consumption frequency of our identified foods categories during the 2-days period. Just as for the consumption amount per occasion, we conducted one-way ANOVA's to determine if there is a significant difference in consumption frequency across the regular and light variants in the different product categories. As consumption frequency of food items is mostly driven by personal taste and not by characteristics such as gender, age or household size, we now exclude the OLS regressions.

Nuts and peanuts

Consumption frequency of the regular and light variant of peanut butter does not differ significantly, $F(1,319)=0.16$, $p=0.69$).

Dairy

For fruit yoghurt, the ANOVA shows a significant difference between the consumption frequency, $F(2,271)=3.15$, $p=0.04$. The Tukey post-hoc test however only shows only a marginally significant difference between semi-skimmed and skimmed fruit yoghurt ($p=0.08$), with skimmed fruit yoghurt ($M=1.19$, $SD=0.42$) being consumed somewhat more often than semi-skimmed yoghurt ($M=1.06$, $SD=0.24$). In the whipped cream / crème fraîche category we find that the reduced fat variant ($M=1.50$, $SD=1.29$) is consumed more frequently than the full-fat variant ($M=1.16$, $SD=0.44$), $F(1,165)=5.97$, $p=0.02$). For coffee creamer the mean frequency of consumption is $M=2.94$ ($SD=2.52$) for whole milk, $M=3.85$ ($SD=2.95$) for semi-skimmed milk, and $M=3.58$ ($SD=3.24$) for skimmed milk, $F(2,652)=4.78$, $p=0.01$. The consumption frequency of whole milk differs significantly from that of skimmed milk, $p=0.01$. For fruit yoghurt, whipped cream / crème fraiche and coffee creamer we thus

find some evidence that people who consume a food more frequently, choose a variant that is lower in fat.

In the hard cheese category we find significant differences, $F(2,1862)=16.35$, $p<0.01$, that are opposite to what we expected. The post-hoc Tukey test shows that 45+ cheese ($M=2.06$, $SD=1.19$) is consumed significantly ($p<0.01$) more often than the 30+ ($M=1.69$, $SD=1.00$) and 20+ variant ($M=1.55$, $SD=0.90$). It should be noted that in the period the data was collected, lower-fat cheeses were considerably more expensive than their full-fat counterparts, which could thus (partly) explain the higher consumption frequency of full-fat cheeses.

For all other products in the dairy category, consumption frequency did not significantly differ.

Cereal products

Both the consumption frequency of crisp bread and potato crisps did not differ significantly across the regular and light variants, $F(2,248)=1.40$, $p=0.25$ and $F(2,445)=0.91$, $p=0.40$, respectively.

Fats

For both butter and margarine we see a clear trend of low-fat variants being consumed more frequently than full-fat variants. Full-fat butter is consumed on average $M=1.77$ ($SD=1.28$) times during two days, while this is $M=2.49$ ($SD=1.86$) times for reduced fat butter, $F(1,529)=14.40$, $p<0.01$. For margarine the low-fat ($M=2.80$, $SD=1.74$) and light ($M=2.76$, $SD=1.77$) variants are consumed most frequent, followed by 30-50% fat ($M=2.18$, $SD=1.22$), 65-75% fat ($M=1.90$, $SD=1.27$), and the full-fat variant ($M=1.71$, $SD=1.24$), $F(4,2146)=34.11$, $p<0.01$. The post-hoc test shows that all variants, except the 65-75% fat variant are consumed more frequently than the full-fat variant ($p<0.01$). Furthermore, the low-fat and light variant are also consumed significantly more often than the 65-75% fat variant and the 30-50% fat variant ($p<0.01$).

We do not find any significant differences for “AH Bewust” (the margarine variant) and cooking fat.

Sugar and confectionary

Only for syrups the ANOVA shows a significant difference, $F(2,121)=3.44$, $p=0.04$. According to the Tukey post-hoc test, only the difference between regular syrup ($M=1.53$, $SD=0.96$) and syrup without added sugar ($M=2.28$, $SD=2.23$) is significant, $p=0.04$.

Cakes

For both the categories cake + apple pie and croissants, the consumption frequency is the same for the variant with dairy butter and the variant without dairy butter, $F(1,272)=0.06$, $p=0.81$, and $F(1,131)=0.11$, $p=0.74$ respectively.

Non-alcoholic beverages

For coke, consumption frequency of the light variant ($M=3.17$,$SD=2.82$) is significantly higher as consumption of the regular variant ($M=2.67$,$SD=2.40$), $F(1,864)=8.04$, $p<0.01$. This is not surprising, as coke is a caffeine providing drink on which people can become physically dependent. Heavy drinkers of coke tend switch to the light variant to reduce their sugar consumption.

Quite surprisingly, for fruit juices, the consumption frequency of the regular variant ($M=2.04$, $SD=1.68$) is higher than of the light variant ($M=1.75$,$SD=1.12$), $F(1,869)=5.67$, $p=0.02$.

Condiments and sauces

The only product in this category that shows a significant difference in consumption frequency is mayonnaise. Quite surprisingly, full-fat mayonnaise ($M=1.43$, $SD=0.86$) is consumed more frequently than 25% fat mayonnaise ($M=1.12$, $SD=0.37$), $F(1,788)=15.55$, $p<0.01$.

Summary of results consumption amount per occasion

Of the 36 product categories that we tested, only 8 show a higher consumption of the light variants than of the regular variants. For 3 categories it is the other way around. Hence, also in terms of consumption frequency, there is only limited evidence that light claims lead to increased consumption. In some of these categories, a reverse causality also seems likely. In case of coke and coffee creamer, it is more likely that people switched to the light variant because they drink much coke or coffee instead of the other way around. For butter and margarine it is very well possible that the “light” claim does not increase consumption but that the “regular” claim decreases consumption. The full-fat variant could be regarded as a special treat that is only allowed at special occasions.

6. Discussion

We started our paper with the hypothesis that “light” claims would increase consumption, either because of their psychological impact (for example, reduced consumption guilt) or because of a

physiological effect (for example, less energy is provided by the product). Using extensive data from the National Dutch Food Consumption survey we analysed intake of regular and "light" variants for 36 different products. For the majority of the products, no significant differences were found between the consumption amount and consumption frequency of regular and "light" products. Hence, we can conclude that we have not found sufficient evidence to support the hypothesis. For the majority of products, consumers apparently do not increase their consumption when they choose a "light" variant instead of a regular variant.

For a couple of products, we did find significant differences in either consumption amount per occasion or consumption frequency. A question that rises is whether this worrisome. In Table 8 we translated the number of grams consumed to the number of calories consumed for the product categories that showed a significantly higher consumption (frequency) of the "light" than the regular variants. For all but one category, the amount of calories that is consumed is still lower or the same when the "light" variant is chosen than when the regular variant is chosen. For example, full-fat margarine is both consumed in smaller portions and less frequent than the "light" variants. Full-fat margarine is consumed in portions of 10 grams, approximately 1.7 times per two days. The calorie density is 7.22, leading to a total consumption of 120 calories in two days. Low-fat margarine is consumed in portions of 12 grams, approximately 2.8 times per two days. The calorie density is 3.54, leading to a total consumption of 118 calories. So even for a category like margarine, where low-fat variants are consumed both in larger portions and more often, choosing the low-fat variant still does not lead to an increase in calorie intake as compared to consuming the full-fat variant. There is one exception, though. For fromage frais with fruit flavour slightly more calories are consumed when choosing the semi-skimmed over the whole variant. But as mentioned previously, fromage frais is consumed by only a small number of respondents and hence this could have a different cause.

Taken everything together, there seems to be little reason to worry about people eating more from "light" variants than from their regular counterparts. In fact, the finding that in some categories more is consumed of the regular than of the "light" variant might actually be more worrying. Note that we not dispute the finding that in controlled experiments, labels like "low-fat" or "healthy" increase consumption (Cavanagh and Forestell, 2013; Provencher et al, 2009; Shide and Rolls, 1995; Wansink and Chandon, 2006), but we do claim that in real life, the taste, texture, price and countless other factors that differentiate "light" product from "regular" products, apparently counteract any consumption-increasing effect that the label might have.

Ours is one of the first studies that examined the relation between "light" claims and consumption frequency. Now, an important direction for further research is to establish the direction of causality. For example, when considering coke, one may wonder whether people have

increased their consumption frequency of light coke because it does not contain sugar or did they already have a high coke consumption and switched to light coke to prevent weight gain? If the availability of light products gives people an excuse to start consuming it more frequently, this could be harmful. If however the consumption frequency would be the same regardless of whether a "light" variant is or is not available, it is beneficial that light variants exist.

Another interesting finding that warrants further research is the inverse relation between household size and consumption amount for a number of product categories. It has been suggested in previous work that eating alone could lead to higher intake than eating with companions (Fischler, 2011). If consumers in small households indeed consume more than consumers in large household because the food is divided over less people, this could be quite worrying indeed. In the Netherlands, household size has steadily declined in the past years (CBS, PBL, Wageningen UR, 2012). If this trend continues, our waistlines might grow in parallel.

Figures

Figure 1: Age distribution of the sample versus the Dutch population

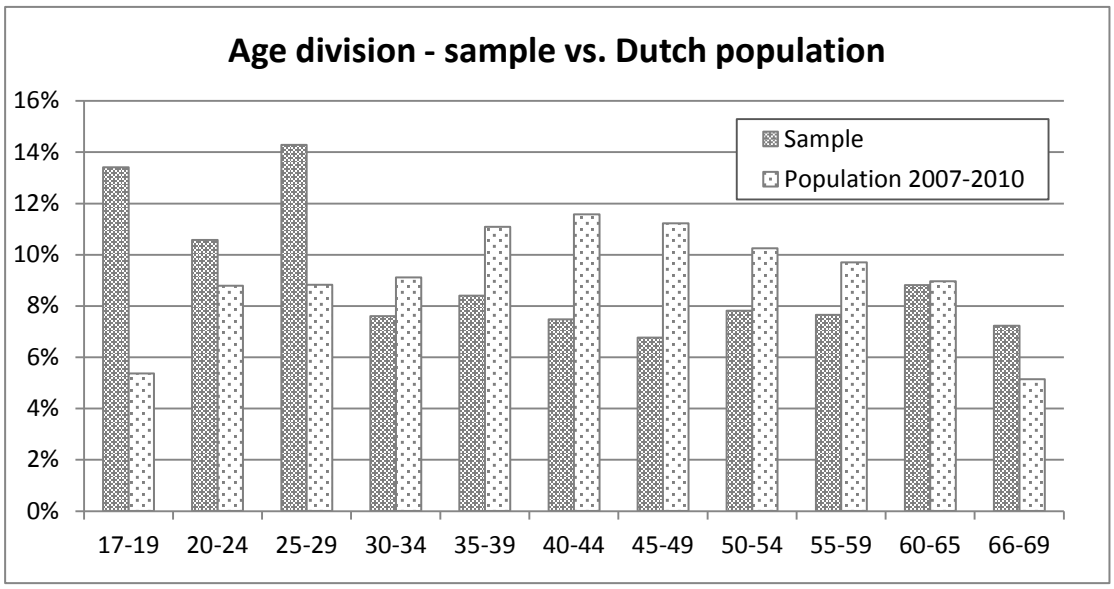
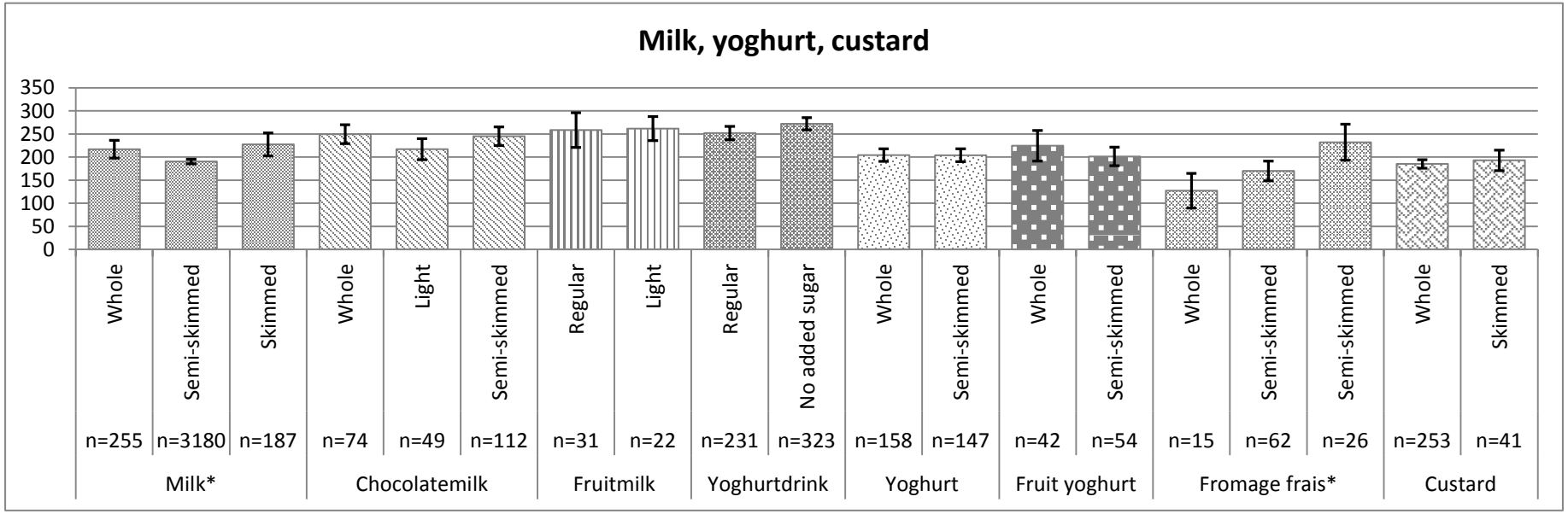
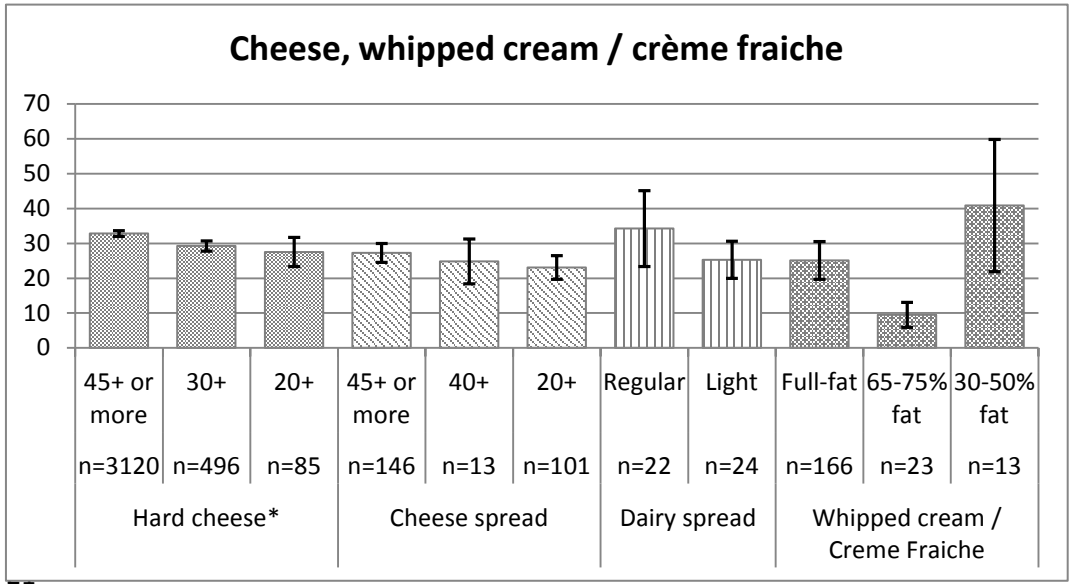


*Figure 2: Mean consumption of the identified food categories. Category names with a * contain significant differences as tested by a one-way ANOVA*





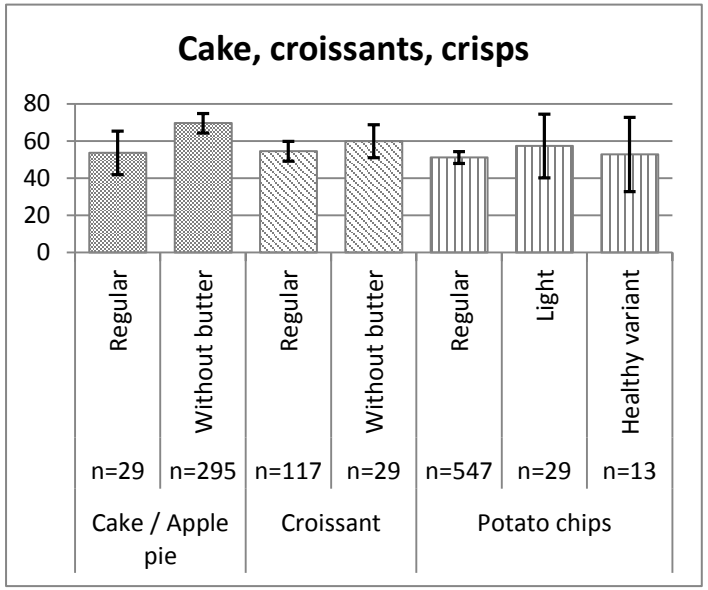
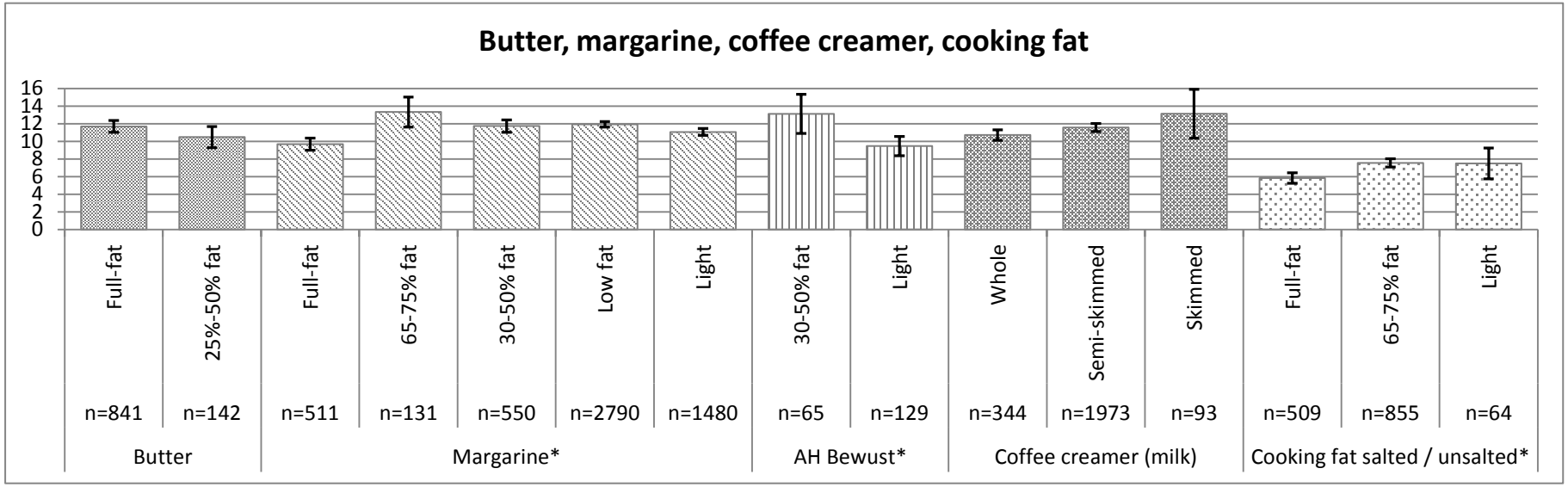


Figure 2 - Continued



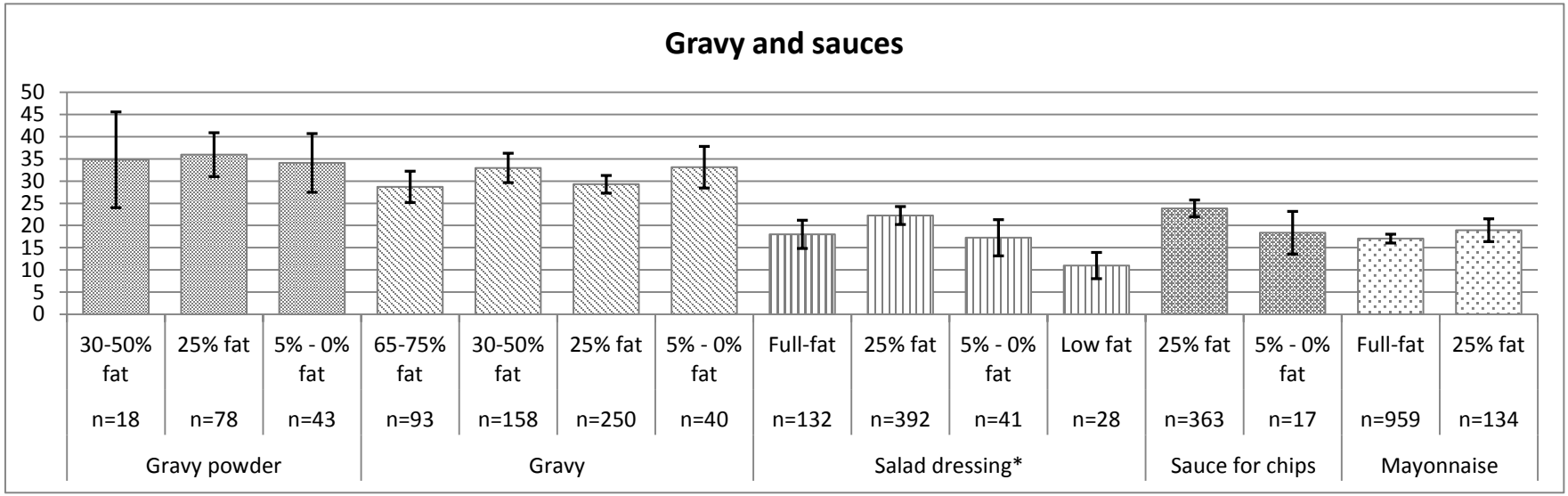
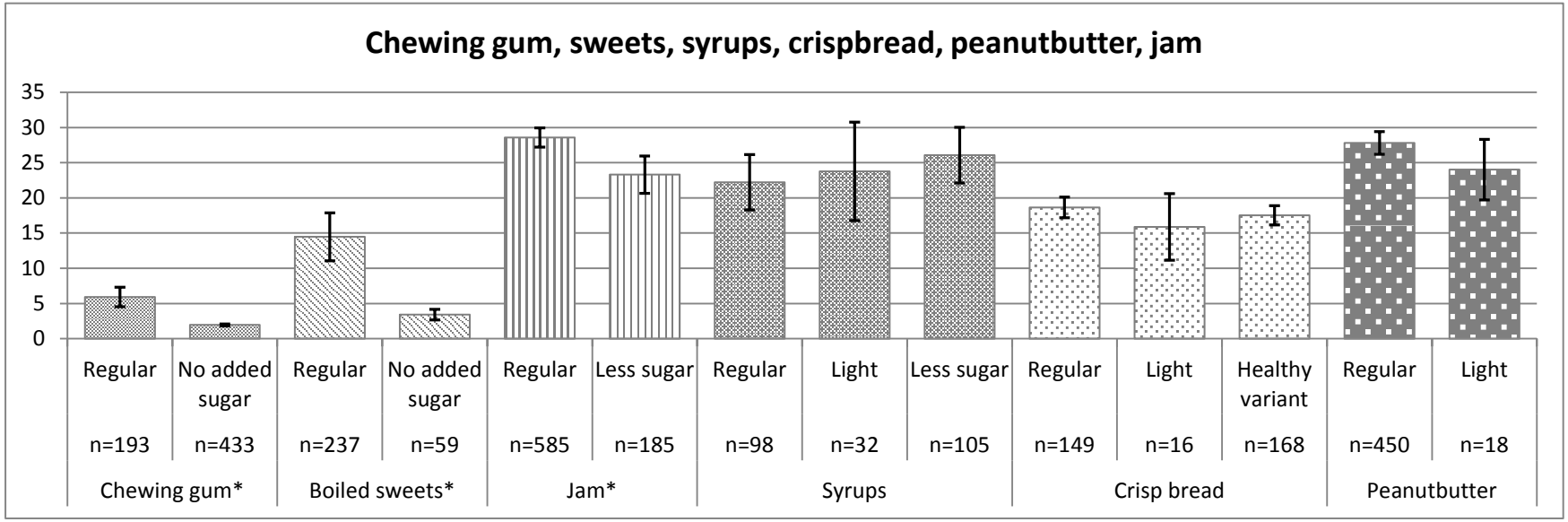
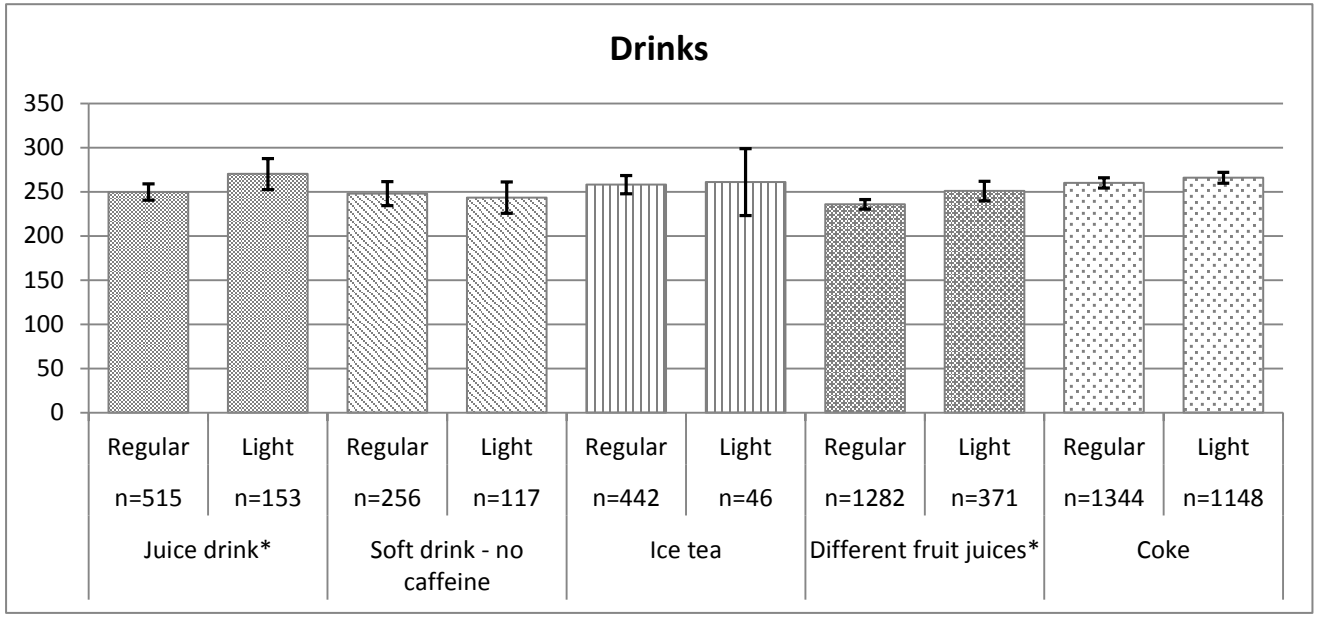


Figure 2 – Continued





Tables

Table 1: Overview variants

"Regular" variants	"Light" variants
Regular	Light
Whole	Semi-skimmed
45+ or more	Skimmed
Full-fat	Less sugar
	No added sugar
	40+
	30+
	20+
	65-75% fat
	30-50% fat
	25% fat
	5% - 0% fat
	Low-fat
	Healthy variant that also is lower in calories
	Prepared without dairy butter

Table 2: Food categories and their variants (number of respondents in brackets)

Food category	Variants (number of respondents in brackets)
Peanut butter	Regular (308) / Light (13)
Milk	Whole (114) / Semi-skimmed (1260) / Skimmed (88)
Chocolate milk	Whole (56) / Semi-skimmed (83) / Light (35)
Fruit milk	Regular (21) / Light (17)
Yoghurt drink	Regular (147) / No added sugar + less sugar + light (208)
Plain yoghurt	Whole (112) / Semi-skimmed (115) / Skimmed (398)
Fruit yoghurt	Whole (39) / Semi-skimmed (51) / Skimmed (184)
Fromage frais fruit	Whole (15) / Semi-skimmed (58) / Skimmed (22)
Hard cheese	45+ (1517) / 30+ (293) / 20+ (55)
Cheese spread	45+ (102) / 30-40+ (11) / 20+ (72)
Dairy spread	Regular (20) / Light (18)
Custard	Whole (216) / Skimmed (35)
Whipped cream / Crème fraiche	Full-fat (143) / 30-75% fat (24)
Coffee creamer	Whole (117 / Semi-skimmed (512) / Skimmed (26)
Crisp bread	Regular (109) / Healthy (127) / Light (15)
Potato chips	Regular (412) / Healthy (11) / Light (25)
Butter	Full-fat (474) / 25%-30% fat (57)
Margarine	Full-fat (298) / 65-75% fat (69) / 30-50% fat (252) / Low fat (996) / Light (536)
AH Bewust (margarine variant)	30-50% fat (33) / Light (53)
Cooking fat salted / unsalted	Full-fat (474) / 25%-30% fat (57)
Jam	Regular (383) / Less sugar (125)
Chewing gum	Regular (111) / No added sugar (206)
Boiled sweets	Regular (139) / No added sugar (28)
Syrups	Regular (64) / Less sugar (46 / Light (14)
Cake / Apple pie	Regular (25) / Without butter (249)
Croissant	Regular (107) / Without butter (26)
Juice drink	Regular (262) / Light (69)
Soft drink - no caffeine	Regular (128) / Light (55)
Ice tea	Regular (179) / Light (25)
Different fruit juices	Regular (657) / Light (214)
Coke	Regular (504) / Light (362)
Gravy powder	30-50% fat (16) / 25% fat (74) / 5% - 0% fat (43)
Gravy	65-75% fat (89) / 30-50% fat (146) / 25% fat (223) / 5% - 0% fat (38)
Salad dressing	Full-fat (119) / 25% fat (334) / 5% - 0% fat (37) / Low fat (24)
Sauce for chips	25% fat (304) / 5% - 0% fat (14)
Mayonnaise	Full-fat (670) / 25% fat (120)

Table 3: Control variables included in the regression analysis

Variables	Reason to include
Used in recipe / fat during cooking	When a food is used as an ingredient in a meal, less is used than when it is consumed "as is" (M=18.1 and M=96.7 respectively, t(35718)=31.85, p<0.00). The choice for a regular or light product might depend on whether it used as an ingredient or consumed. For example, semi-skimmed milk can be preferred for drinking, but whole milk for baking. Products like butter and margarine can be consumed as is, but can also be used as fat during cooking. No distinction will be made whether the product is used as an ingredient in a recipe or as fat during cooking.
Consumption moment	"Snacking" is a different food consumption experience than "eating a meal" (Wansink et al 2010). Unhealthy food and small portions are associated with snacking, while large portions and high quality foods are associated with eating a meal (Wansink et al 2010). The consumption moment can thus influence which food is chosen and how much is consumed. Breakfast, lunch and dinner are coded as meals. All other moments are coded as snacks.
Place	In a restaurant, the amount of food and drinks served is pre-determined, while in a home situation the person consuming the food can usually decide this for him or herself. Multiple studies have shown that the bigger the portion size served, the higher the consumption (for a review see Zlatevska et al 2011). Furthermore, certain foods might be more likely to be consumed in an out of home situation (e.g. carbonated soft drinks) than others (e.g. milk). The place of consumption is divided in three categories: (1) home and at friends, (2) work or school, and (3) restaurant or other out-of-home setting.
Age	As people grow older they need less energy. According to the Dietary Guidelines for Americans (US Department of Agriculture and US Department of Health and Human Services, 2010), men with a sedentary lifestyle that are between 19-30 years old need 2,400-2,600 calories per day, while those above 50 need 2,000-2,200 per day. Use of "light" products might also vary across age groups.
Gender	Women have lower energy needs than men and hence tend to eat smaller portions. Women are also more likely to consume "light" products (Fulkerson et al, 2004).
BMI	As discussed in the literature section, different types of relations between BMI and consumption of artificial sweeteners have been found. Those with a high BMI might try to lose weight by using "light" products. Consumption quantities are also likely to be related to BMI.
Household size	The household size determines how much people the food has to be divided over and hence can influence consumption amounts.
Education	People with a higher education are often more knowledgeable about healthy foods and nutrients (Wardle et al, 2000) and find it easier to follow a healthy diet (Henson et al, 2010). This can lead to healthier choices, including choosing "light" products and small portions.
Follows diet	A dummy will be included for respondents that follow an energy restricted diet, as they are likely to choose small portions and light products. Furthermore, depending on the product category, also specific diets will be included, such as a diet for diabetics when analysing product variants with less/no sugar.
Follows rule for food	Eating patterns are influenced by someone's beliefs and cultural background. Following a specific dietary rule like a vegetarian diet will influence consumption quantities. Hence, two dummies will be included, one for those respondents that follow a religious rule and one for those who follow a non-religious rule like vegetarian or macrobiotic.

Table 4: Consumption amount in grams per consumption occasion. Standard deviations are displayed in brackets. Significant results are it italic text.

		Regular variant	Light variant 1	Light variant 2	Light variant 3	Light variant 4	F-value
Nuts	Peanutbutter	27.8 (17.4)	24.0 (8.6)				F(1,466)=0.84
Dairy	*Milk*	*216.9 (154.7)*	*190.4 (140.5)*	*227.5 (172.8)*			*F(2,3619)=9.38**
	Chocolate milk	249.6 (88.7)	245.2 (108.4)	217.1 (79.0)			F(2,232)=1.88
	Fruit milk	258.5 (102.2)	261.6 (59.1)				F(1,51)=0.02
	Yoghurt drink	252.0 (111.9)	272.1 (123.3)				F(1,552)=3.85
	Plain yoghurt	204.2 (86.1)	203.9 (85.9)	196.5 (90.1)			F(2,874)=0.71
	Fruit yoghurt	224.6 (106.6)	201.1 (73.9)	204.0 (72.0)			F(2,312)=1.38
	Fromage frais-fruit	*127.2 (67.9)*	*170.0 (83.2)*	*232.0 (96.7)*			*F(2,100)=8.20**
	Hard cheese	*32.8 (22.7)*	*29.3 (16.5)*	*27.5 (19.4)*			*F(2,3689)=7.62**
	Cheese spread	27.2 (16.4)	24.8 (10.6)	23.1 (17.3)			F(2,257)=1.93
	Dairy spread	34.2 (24.5)	25.3 (12.6)				F(1,44)=2.52
	Custard	185.2 (74.2)	193.0 (70.4)				F(1,292)=0.40
	Whipped cream / Crème fraiche	25.1 (35.2)	20.8 (24.8)				F(1,200)=0.48
	Coffee creamer	10.7 (5.6)	11.6 (10.4)	13.1 (13.5)			F(2,2407)=2.33
Cereal products	Crisp bread	18.6 (9.0)	17.5 (8.9)	15.9 (8.8)			F(2,330)=1.06
	Potato chips	51.2 (38.7)	52.8 (33.0)	57.3 (44.9)			F(2,586)=0.36
Fats	Butter	11.7 (9.9)	10.5 (7.2)				F(1,981)=1.88
	Margarine	*9.7 (.08)*	*13.3 (9.9)*	*11.7 (8.3)*	*11.9 (8.7)*	*11.1 (7.7)*	*F(4,5457)=10.63**
	AH Bewust (margarine variant)		*13.1 (9.0)*	*9.5 (6.3)*			*F(1,192)=10.83**
	Cooking fat salted / unsalted	*5.8 (6.8)*	*7.6 (7.1)*	*7.5 (7.06)*			*F(1,1425)=9.82**
Sugar and confectionary	*Jam*	*28.6 (16.9)*	*23.3 (18.3)*				*F(1,768)=13.13**
	Chewing gum	*5.9 (9.7)*	*2.0 (1.4)*				*F(1,624)=69.99**
	Boiled sweets	*14.5 (26.6)*	*3.4 (2.9)*				*F(1,294)=10.16**
	Syrups	22.2 (19.7)	26.1 (20.4)	23.8 (19.4)			F(2,232)=0.95
Cakes	Cake / Apple pie	53.7 (30.9)	69.6 (45.5)				F(1,322)=3.39
	Croissant	54.5 (29.3)	59.9 (23.5)				F(1,144)=0.84
Non-alcoholic beverages	*Juice drink*	*249.7 (107.3)*	*270.1 (109.7)*				*F(1,666)=4.21**
	Soft drink - no caffeine	247.9 (110.6)	243.3 (96.7)				F(1,371)=0.15
	Ice tea	258.1 (109.3)	261.0 (127.5)				F(1,486)=0.03
	Different fruit juices	235.8 (101.2)	250.9 (107.9)				*F(1,1651)=6.25**
	Coke	260.0 (108.1)	265.9 (109.5)				F(1,2490)=1.81
Condiments and sauces	Gravy powder		34.8 (21.7)	35.9 (21.9)	34.1 (21.45)		F(2,136)=0.10
	Gravy		28.7 (17.1)	32.9 (21.0)	29.3 (16.0)	33.1 (14.7)	F(3,537)=2.00
	Salad dressing	18.0 (18.6)	22.2 (20.3)	17.2 (12.9)	11.0 (7.6)		*F(3,589)=4.55**
	Sauce for chips		23.8 (18.3)	18.4 (9.4)			F(1,378)=1.49
	Mayonnaise	17.0 (15.8)	18.9 (15.0)				F(1,1091)=1.69

Table 5: Estimated coefficients and associated t-values (in brackets) of the light variants + the F-values and R^2 of the regression equations.
Note that all results are based on the regressions that include both the control variables listed in Table 3 and the "light" variants.

	Light variant 1	Light variant 2	Light variant 3	Light variant 4	F-value	R^2
Peanutbutter	-1.88 (-0.46)				F(13,453)=3.38	0.09
Milk	-2.92 (-0.38)	*27.43 (2.40*)*			F(16,3605)=120.66	0.35
Chocolate milk	2.48 (0.17)	-45.07 (-2.45*)			F(15,219)=2.14	0.13
Yoghurt drink	*21.63 (2.06*)*				F(14,537)=3.57	0.09
Plain yoghurt	-1.80 (-0.20)	-1.15 (-0.16)			F(16,859)=18.42	0.26
Fruit yoghurt	-24.67 (-1.55)	-22.91 (-1.75)			F(16,297)=1.87	0.09
Fromage frais-fruit	9.85 (0.37)	*69.67 (2.33*)*			F(15,87)=2.54	0.30
Hard cheese	-1.34 (-1.23)	-2.02 (-0.84)			F(16,3680)=11.11	0.05
Cheese spread	-1.11 (-0.23)	-3.8 (-1.66)			F(15,244)=1.58	0.09
Custard	-3.30 (-0.24)				F(13,280)=3.43	0.14
Whipped cream / Crème fraiche	*-14.44 (-2.19*)*				F(15,185)=3.15	0.20
Coffee creamer (milk)	0.72 (1.18)	2.31 (1.91)			F(16,2392)=1.49	0.01
Crisp bread	-0.93 (-0.93)	-2.50 (-1.06)			F(14,316)=2.17	0.09
Potato chips	2.18 (0.20)	5.48 (0.74)			F(14,574)=3.37	0.08
Butter	-1.89 (-2.12*)				F(14,968)=6.01	0.08
Margarine	*2.33 (2.98*)*	0.96 (1.86)	*0.92 (2.19*)*	0.32 (0.71)	F(18,5426)=41.07	0.12
AH Bewust (margarine variant)	*-2.67 (-2.36*)*				F(13,180)=5.96	0.30
Cooking fat salted / unsalted	*1.33 (3.41*)*	1.31 (1.42)			F(16,1410)=6.71	0.07
Jam	-4.13 (-2.80*)				F(15,751)=3.41	0.06
Chewing gum	-4.33 (-9.04*)				F(14,611)=7.92	0.15
Boiled sweets	-7.57(-1.93)				F(14,281)=2.51	0.11
Syrups	-0.94 (-0.33)	1.88 (0.45)			F(15,217)=3.56	0.20
Cake / Apple pie	15.27 (1.74)				F(14,309)=1.61	0.07
Croissant	4.81 (0.77)				F(13,132)=0.57	0.05
Juice drink	20.82 (1.89)				F(13,652)=3.06	0.06
Soft drink - no caffeine	18.27 (1.24)				F(13,355)=2.79	0.09
Ice tea	20.73 (1.20)				F(14,465)=4.42	0.12
Different fruit juices	11.9 (1.96)				F(15,1636)=4.70	0.04
Coke	7.13 (1.50)				F(14,2475)=6.87	0.04
Gravy powder	3.50 (0.62)	1.51 (0.25)			F(13,127)=1.30	0.12
Gravy	*4.67 (2.03*)*	1.43 (0.67)	5.12 (1.51)		F(16,523)=2.45	0.07
Salad dressing	*3.93 (2.02*)*	0.19 (0.06)	*-9.78 (-2.37*)*		F(17,575)=2.96	0.08
Sauce for chips	-6.65 (-1.51)				F(15,363)=3.10	0.11
Mayonnaise	-2.31 (-1.61)				F(15,1077)=12.46	0.15

Table 6: Significant (p<0.05) regression coefficients of all other explanatory variables in the OLS regressions with consumption amount per occasion as the dependent variable. Please refer to Table 5 for the associated F-values and R^2.

	consumed as is	snack moment	work / school	restaurant / other	age	gender	BMI	household size	medium education	high education	religous rule	other rule	diet - loose weight	diet - allergy
# of times significant	10	15	10	6	16	23	5	12	3	10	1	6	5	2
Peanutbutter					-0.17 (-2.71)	-7.48 (-4.60)				-5.04 (-2.40)				
Milk	222.88 (36.33)	-94.49 (-20.52)	37.73 (5.50)		-1.09 (-7.76)	-47.64 (-12.1)	1.40 (3.34)			-15.00 (-3.05)				
Chocolatemilk			-50.79 (-3.07)											
Yoghurtdrink		-30.81 (-2.40)	54.80 (3.61)			-40.88 (-4.09)								
Plain yoghurt	189.14 (16.28)	26.72 (2.64)			-0.45 (-2.38)			-5.52 (-2.73)						
Fruit yoghurt	203.65 (2.65)					-18.56 (-2.08)	2.48 (2.94)							
Fromage frais fruit														
Hard cheese	-5.65 (-5.02)	-2.67 (-2.77)			-0.15 (-5.74)	-6.47 (-8.91)		-0.72 (-2.54)		-2.68 (-3.00)				
Cheese spread					-0.16 (-2.25)	-6.20 (-2.79)								
Custard						-31.33 (-3.49)			-26.32 (-2.64)			-80.8 (-2.91)	62.37 (3.26)	-122.83 (-2.19)
Whipped cream / Crème fraiche	21.04 (3.85)	-16.94 (-2.88)						-4.39 (-2.57)				-24.39 (-2.17)	-39.89 (-2.68)	
Coffee creamer			-1.58 (-2.72)											
Crisp bread		-2.92 (-2.13)	4.07 (2.34)				0.25 (2.47)							
Potato chips			-22.92 (-2.06)	-16.67 (-2.13)		-12.73 (-3.94)		-4.24 (-3.63)	-9.23 (-2.30)	-9.23 (-2.26)				
Butter	5.41 (6.86)	-1.93 (-2.10)			-0.05 (-2.52)	-2.24 (-3.61)		-0.75 (-2.89)		-2.07 (-2.61)				
Margarine	6.41 (10.43)	-3.49 (-10.41)	2.73 (9.43)	2.10 (4.54)	-0.05 (-6.51)	-3.72 (-16.90)		-0.22 (-2.51)		-1.12 (-4.10)			-1.26 (-3.17)	

Table 6: Continued

	consumed as is	snack moment	work / school	restaurant / other	age	gender	BMI	household size	medium education	high education	religous rule	other rule	diet - loose weight	diet - allergy
# of times significant	10	15	10	6	16	23	5	12	3	10	1	6	5	2
AH Bewust (margarine variant)		-3.54 (-2.38)				-3.79 (-3.75)						16.81 (2.45)	-6.77 (-4.17)	
Cooking fat salted / unsalted	5.36 (5.97)	-3.01 (-2.47)			-0.04 (-3.2)	-0.93 (-2.55)		-0.59 (-3.94)				5.78 (3.36)		
Jam						-3.98 (-3.13)	-0.37 (-2.39)							
Chewing gum					0.07 (3.48)						5.26 (2.70)	7.32 (3.95)		
Boiled sweets					-0.36 (-3.56)			-2.42 (-2.29)						
Syrups					-0.25 (-2.56)	-9.80 (-3.64)		-2.04 (-2.29)						
Cake / Apple pie			-17.77 (-2.52)											
Croissant														
Juice drink		-23.72 (-2.35)		25.86 (1.98)		-30.18 (-3.52)			-24.38 (-2.43)					
Soft drink - no caffeine		-35.92 (-2.66)			-1.49 (-3.19)	-39.59 (-3.39)								
Ice tea		-31.80 (-2.96)	68.66 (4.88)	56.81 (3.77)										
Fruit juices					-1.05 (-5.6)	-12.69 (-2.48)		-6.61 (-3.52)		-17.75 (-2.74)		-44.12 (-3.38)		
Coke		-35.53 (-6.64)	21.40 (2.99)	12.55 (2.07)		-18.81 (-4.12)								
Gravy powder						-8.77 (-2.21)								
Gravy						-0.16 (-3.07)	-4.06 (-2.64)			-4.00 (-2.22)			-6.26 (-2.03)	39.90 (2.21)
Salad dressing	5.55 (2.62)				-0.21 (-3.89)	-3.84 (-2.41)				-4.93 (-2.39)				
Sauce for chips				-5.21 (-2.35)	-0.28 (-3.58)	-5.67 (-3.05)		-1.47 (-2.16)		-6.14 (-2.54)				
Mayonnaise	9.86 (10.12)	-3.48 (-3.02)			-0.15 (-4.32)	-2.35 (-2.57)		-0.70 (-2.10)						

Table 7: Consumption frequency. Standard deviations are displayed in brackets. Significant results are it italic text.

		Regular variant	Light variant 1	Light variant 2	Light variant 3	Light variant 4	F-value
Nuts	Peanutbutter	1.46 (0.69)	1.38 (0.51)				F(1,319)=0.16
Dairy	Milk	2.24 (1.68)	2.52 (1.89)	2.13 (1.43)			F(2,1459)=2.95
	Chocolate milk	1.32 (0.72)	1.35 (0.74)	1.40 (0.77)			F(2,171)=0.12
	Fruit milk	1.48 (0.81)	1.29 (0.47)				F(1,36)=0.67
	Yoghurt drink	1.57 (1.31)	1.55 (0.81)				F(1,353)=0.03
	Plain yoghurt	1.41 (0.61)	1.28 (0.84)	1.44 (0.68)			F(2,622)=2.28
	Fruit yoghurt	*1.08 (0.35)*	*1.06 (0.24)*	*1.19 (0.42)*			*F(2,271)=3.15**
	Fromage frais-fruit	1.00 (0.00)	1.07 (0.32)	1.18 (0.39)			F(2,92)=1.68
	Hard cheese	*2.06 (1.19)*	*1.69 (1.00)*	*1.55 (0.90)*			*F(2,1862)=16.35**
	Cheese spread	1.43 (0.98)	1.18 (0.40)	1.40 (0.74)			F(2,182)=0.41
	Dairy spread	1.10 (0.31)	1.33 (0.84)				F(1,36)=1.35
	Custard	1.17 (0.38)	1.17 (0.38)				F(1,249)=0.00
	Whipped cream / Crème fraiche	*1.16 (0.44)*	*1.50 (1.29)*				*F(1,165)=5.97**
	Coffee creamer	*2.94 (2.52)*	*3.85 (2.95)*	*3.58 (3.24)*			*F(2,652)=4.78**
Cereal products	Crisp bread	1.37 (0.60)	1.32 (0.72)	1.07 (0.26)			F(2,248)=1.40
	Potato chips	1.33 (0.71)	1.18 (0.40)	1.16 (0.37)			F(2,445)=0.91
Fats	*Butter*	*1.77 (1.28)*	*2.49 (1.86)*				*F(1,529)=14.40**
	Margarine	*1.71 (1.24)*	*1.90 (1.27)*	*2.18 (1.22)*	*2.80 (1.74)*	*2.76 (1.77)*	*F(4,2146)=34.11**
	AH Bewust (margarine variant)	1.97 (1.49)	2.43 (1.86)				F(1,84)=1.47
	Cooking fat salted / unsalted	1.43 (0.77)	1.43 (0.80)	1.42 (0.66)			F(1,995)=0.00
Sugar and confectionary	Jam	1.53 (0.86)	1.48 (0.73)				F(1,506)=0.31
	Chewing gum	1.74 (1.54)	2.10 (1.88)				F(1,315)=3.05
	Boiled sweets	1.71 (1.88)	2.11 (2.02)				F(1,165)=1.04
	Syrups	*1.53 (0.96)*	*2.28 (2.23)*	*2.29 (1.44)*			*F(2,121)=3.44**
Cakes	Cake / Apple pie	1.16 (0.37)	1.18 (0.50)				F(1,272)=0.06
	Croissant	1.09 (0.29)	1.12 (0.33)				F(1,131)=0.11
Non-alcoholic beverages	Juice drink	1.97 (1.58)	2.22 (2.39)				F(1,329)=1.09
	Soft drink - no caffeine	2.00 (1.69)	2.13 (1.74)				F(1,181)=0.21
	Ice tea	2.47 (2.21)	1.84 (1.25)				F(1,202)=1.94
	Different fruit juices	*2.04 (1.68)*	*1.75 (1.12)*				*F(1,869)=5.67**
	Coke	*2.67 (2.40)*	*3.17 (2.82)*				*F(1,864)=8.04**
Condiments and sauces	Gravy powder	1.13 (0.34)	1.05 (0.23)	1.00 (0.00)			F(2,130)=2.30
	Gravy	1.04 (0.21)	1.08 (0.28)	1.12 (0.34)	1.05 (0.23)		F(3,492)=1.77
	Salad dressing	1.09 (0.34)	1.17 (0.49)	1.11 (0.31)	1.17 (0.38)		F(3,510)=1.10
	Sauce for chips	1.19 (0.51)	1.00 (0.00)				F(1,319)=2.43
	Mayonaise	*1.43 (0.86)*	*1.12 (0.37)*				*F(1,788)=15.55**

Table 8: Estimates of the number of calories consumed for the categories in which more is consumed (either in terms of portion size or frequency) of the "light" variants than of the regular variant*

		consumption per occasion	consumption frequency	calorie density	calories consumed
Milk	Whole	216.95	2.30	0.62	306.23
	Semi-skimmed	190.39		0.46	198.94
	Skimmed	227.49		0.35	185.00
Yoghurt drink	Regular	252.00	1.56	0.69	273.34
	No added sugar / less sugar / light	272.07		0.28	119.82
Fruit yoghurt	Whole	209.91	1.08	0.97	218.64
	Semi-skimmed		1.06	0.82	183.34
	Skimmed		1.19	0.48	120.28
Fromage frais- fruit	Whole	127.21	1.00	1.61	204.38
	Semi-skimmed	170.02	1.07	1.21	219.66
	Skimmed	231.99	1.18	0.57	155.79
Whipped cream / Crème fraiche	Full-fat	22.94	1.16	3.39	90.27
	65-75% fat / 30-50% fat		1.50	2.09	71.93
Coffee creamer (milk)	Whole	11.81	2.94	1.54	53.48
	Semi-skimmed		3.85	0.98	44.68
	Skimmed		3.58	0.71	29.91
Butter	Full-fat	11.09	1.77	7.37	144.65
	25%-50% fat		2.49	2.83	78.25
Margarine	Full-fat	9.69	1.71	7.22	119.96
	65-75% fat	13.33	1.90	6.31	159.71
	30-50% fat	11.74	2.18	5.41	138.61
	Low fat	11.94	2.80	3.54	118.36
	Light	11.07	2.76	2.72	83.12
Cooking fat (unsalted)	Full-fat	5.84	1.43	8.72	72.61
	Light	7.50		6.98	74.69
	65-75% fat	7.55		5.05	54.42
Syrups	Regular	24.02	1.53	2.35	86.28
	Less sugar		2.28	1.16	63.78
	Light		2.29	0.02	1.01
Juice drink	Regular	249.69	2.09	0.45	237.45
	Light	270.08		0.04	20.66
Different fruit juices	Regular	235.80	1.89	0.42	185.49
	Light	250.94		0.19	89.18
Cola	Regular	262.96	2.67	0.42	291.31
	Light		3.17	0.00	0.67
Gravy	65-75% fat	28.68	1.08	6.31	194.59
	30-50% fat	32.93		4.15	147.09
	25% fat	29.29		2.08	65.36
	5% - 0% fat	33.11		0.49	17.37

*A category is included when either the ANOVA, the OLS regression or both find a significant difference in the expected direction.

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