Preventing weight gain with calorie-labelling

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What is already known

- Current published literature has only assessed calorie-labelling's impact on calories purchased on single occasions as a snapshot of consumers' purchases precluding the exploration of the effect of calorie-labelling on body-weight.

What this study adds

- Our study provides the first long-term evidence for an impact of calorie-labelling on body-weight. Regular consistent exposure to calorie-labelling of main meals was associated with halving the likelihood of young adults' gaining weight.

Abstract (Word Count = 197)

Objective: Calorie-labelling has been suggested as an anti-obesity measure but there is no evidence for its effect, to date. Early adulthood is a critical life-cycle period for unwanted weight gain and obesity development. This study examined whether providing calorie information would help young adults to avoid weight gain.

Design and Methods: Using a pragmatic interrupted time-series study design, weight-changes over 36-weeks were reported among two year-groups, each of 120 young adults, similar in age, gender and ethnicity, living in fully-catered accommodation. Year-1: subjects were observed without calorie-labelling, apart from a 5-week pilot. Year-2: calorie-labelling was present prominently and consistently at main meals for 30 of the 36 weeks.

Results: Mean weight changes over 36 weeks, per protocol, were +3·5kg (95% CI=2·8-4·1kg) (n=64) in year-1 and -0.15kg (95% CI=-0·7-0·3kg) (n=87) in year-2. Weight changes were significantly different between years, for males and females (both $p<0.001$). Intention-to-treat analysis showed similar results. Relative Risk for weight gain in year-2, compared to year-1, was 0·5 ($p<0·0001$).

Conclusion: Calorie-labelling was associated with a 3·5kg less weight gain, representing a low-cost ‘nudging’ approach to combat the rapid weight gain seen in young adults.

Introduction

Obesity is arguably the greatest global public problem, yet, to date, few low-cost but effective and sustainable obesity prevention interventions exist. Weight gain through body fat accumulation, potentially leading to obesity for many, is most rapid in early adulthood[1]. As most interventions to treat obesity have limited efficacy in the modern obesogenic environment[2], obesity prevention by preventing unwanted weight gain in young adulthood appears an attractive solution.

'Nudging' people towards less energy-dense food choices has been proposed to help people control their calorie intakes[3]. Calorie-labelling at catering outlets aims to alter the 'food-choice architecture', as a simple approach. It has been implemented in various geographic settings, such as New York City[4], and sporadically in commercial and institutional settings elsewhere. Published evaluations of calorie-labelling initiatives, hitherto, report only differences in calories purchased on single occasions[5-8]. Devising a study to examine the effect of calorie-labelling on body weight is difficult under most free-living conditions, given the need for regular exposure to calorie-labelling over a sustained period, with potential opposition from food suppliers, and difficulties in assessing weight changes.

The present study tested the hypothesis that posting the calorie contents of meal components could 'nudge' the food choices of young adults, to regulate energy intakes and thereby avoid unwanted weight gain.

Methods

The study design, an interrupted time series was approved by the Ethics Committee of the College of Medicine, Veterinary and Life Sciences, University of Glasgow on 20/11/2010 and 13/01/2012.

Location and study sample

The study was conducted in the only university residential hall, accommodating 120 young adults in full time education, located a 20-minute walk from the closest grocery shops or alternative catering.

A lifestyle questionnaire was circulated by internal email to each resident as part of a separate university-wide study, to collect information on weight, height, and age, at the beginning (September) and end (May) of both years, an interval of 36 weeks. Self-reported heights and weights data were validated against objectively measured data. For both years, measured data were available for a sub-sample against measurements recorded by nurses or doctors at General Practice (GP) surgeries, and for a second sub-sample against measurements made by a trained researcher within a month of self-reported data collection, as part of another research study. For both years, weights and heights were also available for students studying at the same university but not living in the residential hall.

Catering and calorie-labelling intervention

Two meals daily, breakfast and evening meal, were provided on a five-week menu-cycle, their cost incorporated in a single standard accommodation charge. The menu had been developed by the catering staff, without any expert nutritional guidance. All dishes were prepared and cooked on site. The 5-week menu-cycles, and meal recipes, were identical in year-1 and year-2. Three-course evening meals, selected from 2-3 options, were served onto trays.

The calorie-labelling intervention, agreed by negotiation with the caterers, was limited to evening meals, the main meal of the day. Calorie-labels, identifiable as authentic with the university crest, and from a reliable source, the department of Human Nutrition, were posted prominently at the point of serving, and reinforced by posters in the dining hall. Neither blinding nor randomisation of the intervention was possible while retaining a realistic-setting pragmatic study design for long-term evaluation.

Year 1 (2011-2012)**:** In order to pilot the process and assess acceptability to residents and staff, calorie-labels were posted in the dining room for one complete menu-cycle in the last five weeks of the academic year (April 2012).

Year 2 (2012-2013)**:** Calorie-labels were posted for most of the academic year (for 30 weeks in total out of the 36 weeks of the academic year), starting September 2012. Calorie-labels were removed for six weeks, in the middle of the academic year in order to test the hypothesis that their removal would make any difference to the meals chosen by the students. They were in place for the first four 5-week menu-cycles (20 weeks), removed in the middle of the academic year (February 2013) for 6 weeks, and reinstated in April 2013 for the remaining two menu-cycles (10 weeks). In this final period, additional information on the estimated daily energy requirements of young adults was provided as A4-size posters in the dining room.

Ingredient orders

Details of all the orders placed by the caterers with commercial suppliers for ingredients used in evening meals were provided by the catering staff for analysis, for eight-week periods, November-December 2011-2012, without calorie information, and November-December 2012-2013 when calorie information had been in place for 12 weeks.

Meal selection recording

From the 5-week evening-meal menu-cycle, 14 days were identified as including choices with wide calorie-ranges. The first 100 meals selected on those 14 days were observed, and all items on the trays recorded by the principal researcher, under each calorie-labelling condition (one menu-cycle with calorie information, one with no calorie information and one with calorie information plus daily energy requirements). The cut-off of 100 meals was chosen to avoid any confounding from forced meal choices for subsequent students, if the most popular choices had run out.

Statistical Analysis

Data analysis, using SPSS 19 (Chicago, IL), was performed per protocol and by intention-to-treat. Per protocol analysis used data only from participants who completed the study. Intention-to-treat analysis used imputed data for those with incomplete data for body weight, employing the mean weight-change observed among those who completed the study. Further Intention-to-treat analyses were performed across a range of imputed weight-changes, the means of the upper and lower thirds of the weight-change distributions, and also the mean weight-change of all subjects in both years combined.

After checking normality of distributions using Kolmogrov-Smirnof test, measurements made on the 2011-2012 and 2012-2013 populations residing in the hall and out of the hall were compared using independent t-tests. Paired t-tests were used to examine changes in weight, height and BMI between the beginning (September) and end (May) of each academic year, across equal time-intervals of 36 weeks. Differences between the meal contents of calories, fat, saturated fat, and selected micronutrients in the three time periods, for male and female participants separately were sought using one-way ANOVA and t-tests. Linear regression and Bland-Altman plots were used to assess agreement between methods assessing weight and height. Odds ratio and relative risk were calculated to quantify the association between exposure to calorie-labelling and the risk of gaining weight.

Results

The caloric contents of evening meals offered varied very widely; starters: 18-462 kcal; main courses: 115-1034 kcal; desserts 114-734 kcal. In principle, an individual could choose from 247 to 2230 kcal from the three main components, plus any side dishes such as vegetables, rice, potatoes, and chips. These options were identical during years 1 and 2.

Participants' characteristics for year-1 and year-2 are shown in Table 1. Baseline characteristics did not differ between the two years for weight, height, body mass index, or proportions of smokers and alcohol drinkers (Table 1). The distributions of degree courses were similar in the two groups.

Weight changes

Data on body weight at both baseline and follow-up were available for 64 residents in 2011-2012 and for 87 in 2012-2013 (Figure 1). Weight changes over 36-weeks in the two years, 2011-2012 and 2012-2013, are shown in Table 2, and Figure 2.

Per Protocol Analysis

Year 1: 2011-2012. Weight was gained by 89% (n=57) of the respondents, 4% (n=2) reported unchanged weight, and 8% (n=5) lost weight, over 36 weeks. Mean weight increased during the 36-week period from 66·0(SD12·9)kg to 69·6(SD14·3)kg, and mean BMI from 22·0(SD3·1)kg/m^2 to 23·0(SD3·6)kg/m^2 (both p<0·001).

Year 2: 2012-2013. Weight was gained by 46% (n=40) of the respondents, while 36% (n=31) lost weight and 18% (n=16) remained the same weight. Mean weight was 66·1(SD11·6)kg, and BMI 22·3(SD3·2)kg/m^2 at baseline, and 66·0(SD12·0)kg, BMI 22·3 (SD3·4)kg/m^2 after 36-weeks (both NS).

Comparison of weight changes in Year 1 and Year 2: Weight changes across the 36 weeks observation periods differed between year-1, +3·5(SD2·6)kg, and year-2, -0·16(SD2·4)kg (p<0·001). The difference remained significant when data analysed by gender, with very similar changes for males and females; males +3·8(SD1·90)kg in year-1, and -0·4(SD2·7)kg in year-2 (p=0·03), females +3·1(SD3·0)kg in year-1, and +0·2(SD2·4)kg in year-2 (p<0·001). Relative risk for any weight gain (>0kg) in year-2, compared to year-1, was 0·5 (95% CI=0·4-0·7), p<0·0001. For weight gain>1kg, relative risk 0·6 (95% CI 0·4-0·7) p<0·0001. For weight gain>2kg, relative risk 0·4 (95% CI 0·3-0·5), p<0·0001.

Intention-to-treat analysis, using imputed weight-change values for subjects with incomplete data

Since there were no significant differences between the weight changes observed in males and females, the mean weight change of both sexes combined was employed as the imputed value for subjects with incomplete data. Responders and subjects with incomplete data were not different at baseline for weight, height, BMI, or gender.

Year 1: 2011-2012. Mean weight increased from 65·1(SD12·1)kg to 68·7(SD13·4)kg and mean BMI from 21·7(SD3·0)kg/m^2 to 22·8(SD3·3)kg/m^2 (p<0·001) during the 36-week period.

Year 2: 2012-2013. Mean weight was 66·7(SD14·7)kg, BMI 22·5(SD4·0)kg/m^2 at the start of the year and 66·6(SD15·0)kg, 22·4(SD4·0)kg/m^2 after the 36-week period (both NS).

Comparison of weight changes in Year 1 and Year 2: Weight changes across the 36 weeks observation period were +3·4(SD2·4)kg in year-1 and -0·16(SD2·4)kg in year-2. Weight changes for all subjects in year-1 were significantly greater than in year-2 (p<0·001). The difference remained significant when data analysed separately by gender (both p<0·001). The significant difference between the two years remained when the analysis was conducted across a wide range of imputed weight-changes, using the means of the upper third and the lower third of the weight-change distributions and also the mean weight change of all respondents in year 1 and 2 (1·4kg) (all p<0·001). Relative risk for any weight gain (>0kg) in year-2 compared to year-1 was 0·4 (95% CI=0·3-0·5) p<0·0001. For weight gains >1kg and >2kg, relative risks were 0·4 and 0·3 (all p<0·0001).

Validation of weights and heights

Measured data allowing validation of self-reported data were available for 93 participants measured by GP surgery staff (females=62, males=32), and 19 participants measured by the principal researcher (females=12, males=7). Measured data available with both methods were available for 13 participants (females=8, males=5). There were high correlations between all three methods (r=0·999, p<0·001) for both weight and height. Mean underreporting biases were 0·1kg and -0·001m, with no difference between males and females. Bland-Altman analysis revealed a high level of agreement between methods, without evident bias (Figure 3).

Weight changes between students-residents and students-non residents

Weight-changes in students studying in the same university (non-residents) were available for 1,275 subjects in year-1 and 1,734 subjects in year-2. Students-residents and –non-residents had similar characteristics at baseline in terms of weight (Year-1: 65.8(14.5)kg, Year-2: 65.3(13.5)kg, height (Year-1: 1.72(0.1)m,Year-2:1.7(0.1)m, BMI (Year-1: 22.3(4.6)kg/m^2, Year-2: 22.3(4.5) kg/m^2 and age (Year-1: 20.0(3.8) years old, Year-2: 19.9(2.8) years old . Non-resident-students during year-1 gained 1.8(SD2.6)kg and during year-2 2.1(SD 1.4)kg. Weights changes were significantly different between resident and non-resident students (Year-1, 3.5kg vs 1.8, Year-2 -0.15kg vs 2.1kg, both p<0.001).

Ingredient orders and costs

Orders for all main ingredients for meals and the total calorie contents of food items and ingredients ordered for evening meals during the 2-month periods analysed fell significantly, from 9,209,200 in year 1 to 7,600,320 kcal in year 2 when calorie-labelling had been in place for 10 weeks, a reduction of 18%. Ingredients used mostly for the preparation of desserts fell by 60% and oils used for frying fell by 35%. Total catering expenditure fell by about 33% (Table 3).

Effect of calorie-labelling on the total calories and nutrients per meal chosen, across 3 study periods

Mean kcal, fat, saturated fat, vitamin C, iron, and calcium contents of observed meal choices are shown in Table 4.

Mean calorie contents of meals chosen were significantly different between all study periods. The least calories per tray were observed in period 3, significantly lower than in period 2 both for females ($p<0{\cdot}001$) and males ($p=0{\cdot}01$), and significantly different from period 1 ($p<0{\cdot}001$) (Table 4). Among females, the mean calories per tray fell by 25% between the no-labelling period and the labelling plus nutritional requirements period. Among males, for the same study-periods, calories per meal fell by 15%.

A similar pattern was observed for the meal contents of fat and saturated fat (Table 4). Fat content was reduced during both labelling periods for both males ($p<0{\cdot}001$) and females ($p<0{\cdot}001$). Saturated fat also reduced for both males ($p=0{\cdot}009$) and females ($p=0{\cdot}002$).

There were no differences in the content of selected micronutrients of frequent concern among young people, vitamin C ($p=0{\cdot}309$), iron ($p=0{\cdot}452$), calcium ($p=0{\cdot}527$) in meals chosen.

Reported Use of Labelling

Calorie labelling was valued by the subjects, 35% and 48% (in year-1) reported using them for weight control, 65% and 52% (year-2) for ‘healthier eating’, and the differences between weight changes were large. Caterers were interviewed and welcomed the presence of calorie-labels as a useful tool.

Discussion

Hitherto, there has been no published evidence for any effective low-cost, sustainable, obesity-prevention programme directed at young adults. The present study looked at the effect of providing calorie information on body-weight and followed residents for two academic years in a location where there were few alternatives to in-house catering. During the second year, there was no change in body weight and BMI, which would not be expected on the basis of the evidence on similar student groups[9] and on weight-changes observed in students studying at the same university but living outside the residential hall. That result was significantly different from the weight gain observed in the first year without calorie-labelling. This difference of 3.5kg (about 7 pounds) remained, whether analysed per protocol for completers only, or by intention-to-treat with imputed weight changes for those with incomplete data. The significant avoidance of weight gain in the second year was an exciting new finding, which can plausibly be attributed to the change in food choices, with substantial reductions (by 15-25%) in energy contents of evening meals observed during calorie-labelling. The relative risk 0·5 is striking. Practical constraints in a real-life setting forced a study design which cannot claim absolute proof, but these data support a causal link between calorie-labelling and weight-gain prevention, through reduced calorie contents of meal-selections. We could not identify any other confounding environmental factors or health-promotion initiatives which might have been responsible for such a large difference in weight changes between the two years.

Recognising inherent uncertainties in dietary intake assessment, this study used independently observed and recorded food choices, and the effects of calorie-labelling were corroborated using a triangulation approach from data on ingredient purchasing, collected routinely by the caterers. Guiding young adults towards less calorific choices provided an opportunity for caterers to consider improving the nutritional profile of the meals while keeping within budget. The substantial reduction in ingredient purchasing costs was seen as an important benefit, which should make the intervention sustainable and readily transferable to other settings.

Misreporting of body-weight is a frequent study limitation, and a particular problem among obese subjects, but the self-reported weights and heights of these young adults, mostly still of normal weight, were validated in two ways, and agreed closely with measurements made by a trained observer, and against measurements recorded by nurses or doctors at General Practice (GP) surgeries. In order to avoid biasing responses, students were not informed that the calorie-labelling study and the measurements of heights and weights were related.

There is little existing evidence for an effective obesity prevention strategy in young adults, partly because it has been so difficult to devise study designs aimed at long-term effects which can test transferable interventions in free-living 'realistic' settings. Calorie-labelling has the great advantage of its low cost, but previous studies have only been carried out in commercial settings on single meals, and none examined the relationship between calorie contents of foods bought and body weight change. Such data could only be snapshots of consumers' choices with and without calorie information, precluding any investigations on body weight. In England, under the 'Responsibility Deal', larger restaurant chains have agreed to support a call to voluntarily provide calorie information on their menus[10]. There is no evidence as yet for any effect of this initiative on body weights or the obesity epidemic.

Several factors may have contributed to the success of the present study. The information was very prominent, sited close to the food, reinforced by posters in the dining hall, from a recognisable trusted source, and perhaps most importantly for generating behavioural change, as with commercial marketing messages, the calorie-labelling was present every day for long periods. Previous interventions in commercial settings, with little or no effect on purchases, have generally used less prominent calorie labels. The increase in the calorie-content of the meals chosen by the students, during the short no-labelling-period, may be another indication that calorie-labelling in order to be effective must be present daily and in all catering outlets. Calorie-labelling formatting might need to be adapted or supplemented with other educational materials in order to match the specific needs of other settings or of other populations such as those coming from a low socioeconomic or education background.

This study provides the first data on weight-changes, and much more detailed and longer-term information on consumer responses to calorie-labelling, than has been previously been reported. Importantly, it examined the impact of calorie-labelling among young adults, who are at the most vulnerable stage for weight gain[11]. The proportion of young adults currently attending higher education in the UK is high, including approximately 50% of all school-leavers[12], therefore our study population represents a large proportion of all young adults, not an elite highly-educated sub-group. The residential setting afforded an opportunity to measure weight-changes of consumers over a 36-week period. It was a 'realistic' study, with minimal interference from researchers, and all steps were taken to validate the data in several ways. Measuring food wastage would provide extra strength, but that was not possible in this study. The catered residential setting provided an opportunity to evaluate regular exposure to a controlled intervention whose effects are likely to apply to other catering settings if consumers are exposed to calorie-labelling on a daily basis.

Conclusion

In conclusion, this study has used a careful pragmatic approach to address a difficult research question of real importance for public health, as highlighted by the UK Academy of Royal Medical Colleges[13]. It presents valuable new evidence that regular daily exposure to prominent calorie-labelling may 'nudge' long-term alterations in food choices, sufficient to reduce the weight gain of young adults, in this case with a difference between the year-groups of about 3·5kg. Calorie labelling was associated with a halving of likelihood of weight gain. The data suggest that calorie-labelling may also lead to reduced food purchasing expenditure, and deserves support as a low-cost, transferable intervention for public health strategy.

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Conflict of interest

No authors declare a conflict of interest.

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Declaration of Interests

Authors declare no financial or personal relationships with other people or organisations that could inappropriately influence this piece of work

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Table 1: Participants' characteristics at baseline (October) for year-1 and year-2.

	Year 1 Mean (SD)	Year 2 Mean (SD)	P value
Gender	**F=54%**	**F=58%**	
Age (years)	19·1(2·3)	19·1(0·9)	0·101
Weight (kg)	66·1 (12·9)	66·1 (11·6)	0·065
Height (m)	1·73 (0·1)	1·70 (0·1)	0·079
Body Mass Index (kg/m^2)	22.0(3·1)	22·3 (3·2)	0·064
Smokers (%)	15	13	-
Alcohol consumers (%)	63	65	-
Course/Degree			
Health Sciences (%)	45	43	
Economics and Business (%)	33	29	-
Social Sciences (%)	22	28	
Ethnicity – British (%)	98	97	-

Table 2: Weight and BMI changes over 36 weeks, for year 2011-2012 and 2012-2013, per protocol analysis and intention-to-treat-analysis (mean weight change observed in the respondents was imputed for participants who only provided baseline but not follow-up data).

	Year 1				**Year 2**			
	Baseline Mean(SD)	Follow up Mean(SD)	Change Mean(SD)	P value	Baseline Mean(SD)	Follow up Mean(SD)	Change Mean(SD)	P value
Per Protocol Analysis								
	n= 64 (F=54%)	n=64 (F=54%)			n= 87 (F=58%)	n= 87 (F=58%)		
Weight (kg)	66·1 (12·9)	69·6 (14·3)	3·4 (2·5)	<0·001	66·1 (11·6)	66·0 (12·0)	-0·15(2·4)	0·585
95% CI	62·9-69·4	68·9-73·2	2·8-4·1		63·6-68·6	63·4-68·5	-0·7-0·3	
Intention-to-treat Analysis								
	n=86 (F=65%)	n=86 (F=65%)			n=113 (F=56%)	n=113 (F=56%)		
Weight (kg)	65·3 (12·1)	68·8 (13·3)	3·5(2·2)	<0·001	66·7(14·7)	66·6(15·0)	-0·16(2·1)	0·407
95% CI	62·7-67·9	65·8-71·6	3·0-3·9		64·0-69·4	63·8-69·4	-0·55-0·2	

Table 3: Data from caterers' purchasing orders of main ingredients for two months in year 1, without calorie-labelling, and in year 2 when calorie-labelling was displayed.

	Nov-Dec 2011			Nov-Dec 2012				
Ingredients	**Number of Units**	**kcal**	**Cost (£)**	**Number of Units**	**kcal**	**Cost (£)**	**% change (units)**	**% change (£)**
Meat Products	128	2,680,000	2,861.35	87	1,827,000	2,018.46	-32	-30
Vegetables	123	246,000	449·71	109	218,800	391.36	-11	-10
Potatoes	131	491,250	937·61	89	333,750	451.12	-32	-33
Desserts	61	195,200	342·23	50	160,000	255.99	-18	-18
Oils	19	2,052,000	326·46	13	1,404,000	214.66	-32	-35
Fish Products	51	1,020,000	1199·79	51	1,020,000	1107.18	0	-7
Pasta Products	17	1,774,800	54·26	22	2,296,800	72.04	+29	+32
Other	75	750,000	1194·5	34	340,000	486.69	-55	-60
Total	**605**	**9,209,200**	**7,432·55**	**455**	**7,600,350**	**5,038.82**	**-25**	**-33**

Table 4: Mean (SD) macro- and micro- nutrients chosen by participants (including side dishes) for 4,200 evening meals analysed, over the 14 days of the three study periods.

	Calorie-labels	**No calorie-labels**	**Calorie-labels plus energy requirements**	**Calorie-labels**	**No calorie-labels**	**Calorie-labels plus energy requirements**
		Females			**Males**	
Calories (kcal)	628[1,2] (105)	709 (101)	534[1,2] (116)	692[1,2] (105)	734 (101)	622[1,2] (116)
Fat (g)	29.2[1,2] (8.7)	34 (8)	25[1,2] (9)	33[1,2] (9)	35 (8)	29[1,2] (9)
Saturated Fat (g)	9.5[1,](3)	11.5 (3)	7.5[1,] (3)	11[1,2] (3)	12 (3)	9.5[1,2] (3)
Vitamin C (mg)	77 (78)	89 (97)	67 (81)	73 (69)	86 (80)	82 (81)
Iron (g)	11.8 (10)	15 (15)	11 (12)	14 (13)	16 (15)	15 (15)
Calcium (mg)	243 (354)	356 (723)	250 (374)	319 (656)	440 (968)	303 (512)

Data mean (SD) for macronutrients

Data median (IQ) for micronutrients

(ANOVA and t-tests)

[1]**=** significant at $p<0.01$ vs Period 2

[2]= significant difference at $p<0.01$ between period 1 and period 3