Statement of the Calorie Reduction Expert Group[1]

Background

1. The Public Health Responsibility Deal (PHRD) aims to help improve public health outcomes through a range of initiatives covering food and physical activity as well as alcohol, and health in the work place.

2. In recent decades an increasing proportion of the UK population has gained weight reflecting a chronic positive energy imbalance (i.e. calorie intake exceeding calorie expenditure), and this has led to an increasing prevalence of overweight and obesity. Being overweight or obese increases the risk of a number of diseases, such as cardiovascular disease and some cancers (Prospective Studies Collaboration, 2009).

3. The Calorie Reduction Programme within the Food Network of the PHRD is focused on changing the food environment so that it provides less stimulus for over-consumption and weight gain, but instead facilitates weight maintenance. An Expert Group was therefore convened to examine the evidence on the daily energy imbalance gap, to estimate the level by which calorie intakes would need to fall to reduce the risk of continued excessive weight gain among the population, and to assess the risk this poses to micronutrient status and malnutrition among different population groups.

4. This advice will be used to inform discussion within the Responsibility Deal Food Network on the amount of energy that could potentially be removed from the food supply, as one part of activities to tackle obesity in England.

What is a realistic calorie reduction figure (kcal/person/day) to prevent weight gain in the UK population?

5. The Expert Group was asked to consider different potential approaches to determine the daily energy imbalance gap associated with weight gain trends. The specific examples for consideration were described in papers by Hill *et al.*, (2003 and 2009), Butte and Ellis (2003) and Swinburn *et al.*, (2006 and 2009).

6. In their 2003 paper, Hill *et al.,* postulate that if the rate at which the population is gaining weight is known, then the rate at which body energy is being accumulated and the degree of positive energy balance that produced the weight (and energy) gain can be calculated. From this, it is possible to approximate a figure for reduction in calorie intake that would halt the weight gain of the population. Using datasets from large-scale population studies in the US (NHANES and CARDIA), Hill et al estimated the rate of weight gain within the US population over

[1] Membership of the Calorie Reduction Expert Group can be found at Annex 1.

an 8 year period and the amount of excess energy storage that would be required to support this pattern. Assuming a calorie content of 3500kcal per additional pound in body weight, it was estimated that the median population gain of the USA population is 15kcal/day and 90% of the US population is gaining up to 50 kcal/day. Thus, reducing calorie intake by 50 kcal/d could offset weight gain in around 90% of the population. Based on an energetic efficiency of 50%, they concluded that most of the weight gain seen in the population could be eliminated by reducing calorie intake (or increasing expenditure or a combination of both) by around 100kcal/day.

7. The Expert Group questioned the assumption of 50% energy efficiency for transformation of food energy to weight used by Hill *et al*. They agreed that applying an 80% efficiency estimate would be more appropriate (Diaz *et al.,* 1992, Horton *et al.,*1995). This would reduce the calorie reduction figure to 70 kcal/person/day.

8. Butte and Ellis (2003) measured one year weight gain and estimated energy storage from body composition data in US Hispanic children. They concluded that the energy gaps are greater; for the median between 64-144kcal/day and for the 90^{th} centile 135-263kcal/day, and thus a correspondingly greater intervention would be required to prevent unhealthy weight gain. The Expert Group noted that this conclusion was based on some relatively small subgroups of this selected population, with exceptional weight gains at the upper percentiles.

9. In contrast to the approach employed by Hill, Swinburn *et al.,* used measures of total energy expenditure (TEE) derived from doubly-labelled water studies. From these equations were developed relating energy flux (defined as TEE equivalent to total energy intake in people in energy balance) to body weight in adults, as a means to estimating the rise in energy flux associated with the obesity epidemic.

10. The Expert Group agreed that the approach taken by Hill *et al.,* was simple, straightforward and theoretically sound, and was best suited to the purpose of estimating energy imbalance associated with weight gain in the population. The group therefore agreed that it would be appropriate to adopt the methodology used by Hill *et al.,* to estimate the energy imbalance gap for the population of England.

11. Using Heath Survey for England (HSE) data from 1999-2009, analysis of the weight gain of 20-40year olds shows that the distribution of weight has shifted upwards by 6.2 kg at the median and by 9 kg at the 90^{th} percentile over the 10 years. This equates to an extra calorie intake of 16kcal per day for the median and 24kcal per day for the 90^{th} percentile, assuming energy efficiency for transformation of food energy to weight at 80%. The results from this analysis are lower than the figures found by Hill *et al* mainly due to slower rates of weight gain

in the English population. See Annex 2 for a full description of the analysis including the assumptions made.

12. The Expert Group also considered a reduction of up to 100kcal/person/day at a population level, (the figure estimated by Hill et al (2003) for the USA population (paragraph 8)). They agreed that this level would address energy imbalance and also lead to a moderate degree of weight loss for some individuals. They also agreed that it was unlikely that this level of reduction would be a risk to the population. It was noted that to achieve reduction of energy intake of this amount, the reduction of calories from the food supply would need to be higher as the amount of energy available in the food supply is greater than actual intake, due to wastage.

Would cutting calories into supply by the equivalent of around 100kcal/person/day lead to undernutrition in at risk population groups and/or exacerbate micronutrient deficiencies?

13. The Expert Group discussed the potential negative impact of calorie reduction measures on the general population and more specifically vulnerable groups including children (0-18 years), low weight adults (Body Mass Index (BMI) <18.5) and older adults (aged 75 years and over). Data from the Health Survey for England (HSE) and the National Child Measurement Programme describing the proportions of the population at different BMI thresholds were presented and informed the Expert Group's consideration of whether calorie reductions of 100kcal/person/d would increase the risk of people already underweight or of healthy weight reducing their weight further. It was noted that in the non-institutionalised population, the prevalence of energy under-nutrition is low. The aim of this intervention is to minimise the passive over-consumption facilitated by weak satiety signals and the intervention is unlikely to override the normal physiological mechanisms geared to avoid sustained negative energy balance. This asymmetry of physiological control of appetite would tend to mitigate the risk of a rise in the proportion of underweight individuals.

14. The Group concluded that cutting calories into supply by the equivalent of around 100kcal/person/day would present a low risk of exacerbating undernutrition in the population.

15. The Group concluded that calorie reduction would be undesirable in older adults (aged 75 years or more) because, according to the NDNS, this group is at greater risk of poor nutritional status, particularly those who are institutionalised. It was also agreed that calorie reduction would be inappropriate for children aged under one year of age due to the transitional nature of their diet (i.e. moving from an exclusively milk diet to family foods) and high rates of growth. As children get older, their rate of growth reduces and their requirements for micronutrients are lower in comparison to energy requirements. The Expert Group noted that in SACN's Draft Report on Energy Requirements,

calculation of the energy requirements of young children using expenditure data has yielded lower estimates of energy requirements than those previously suggested by factorial calculation. Thus children over the age of 1-year need not be exempted.

16. Findings from the Scientific Advisory Committee on Nutrition's (SACN) report on the Health and Wellbeing of the British population (2008) were also considered. The report noted that low micronutrient intakes and biochemical status are generally associated with an imbalanced diet, for example, with lower consumption of fish and fish dishes and fruit and vegetables and higher consumption of savoury snacks and, for some analyses, soft drinks, sugar, preserves and confectionery, and alcoholic drinks. Conversely, people with adequate micronutrient intakes and/or biochemical status ate the most fish and fish dishes, fruit and vegetables and nuts and seeds. In its 2008 report, SACN concluded that high fat/sugar foods such as savoury snacks, soft drinks and sugar displace micronutrient-rich foods in the diets of those with low micronutrient intakes and/or biochemical status.

What is the contribution of different food groups to energy intakes? Can any foods or food groups have the calories reduced without risk to micronutrient intakes?

17. The Expert Group examined the contribution of various food categories to calorie intakes in NDNS 2008/09. Alcoholic beverages were one of the top contributors of calories for adults, and this remained when non-consumers in the database were included in the analysis. The Expert Group agreed that consumption of alcoholic beverages provides no important nutritional benefit and consequently that calorie intake from this category could be reduced without adverse effects to micronutrient intake and/or biochemical status.

18. The Expert Group noted that a number of food categories (for example, soft drinks, confectionery, preserves and savoury snacks) make a relatively high contribution to calorie intakes on a population basis (particularly in children), but as a set of categories provide relatively few micronutrients. The Expert Group agreed it is improbable that reducing the proportion of total calorie intake from these food categories would be significantly detrimental to the micronutrient quality of the diet.

19. Fresh fruit and vegetables and those that have undergone only minimal processing should be excluded from calorie reduction measures due to potential adverse effects on micronutrient intakes and/or status.

20. The Expert Group also recommended that care must be taken to ensure that food supply interventions intended to reduce calorie intake

do not increase the proportion of the population that is failing to achieve micronutrient and essential fatty acid recommendations.[2]

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[2] This paper is the work of an independent expert group commissioned by the Department of Health. Its findings do not necessarily represent Department of Health policy.

Annex 1

Membership of the Calorie Reduction Expert Group

Chairman

Professor Ian Macdonald (Chair)	Scientific Advisory Committee on Nutrition, University of Nottingham

Members

Professor Joe Millward	University of Surrey
Dr David Mela	Unilever R&D Vlaardingen, the Netherlands
Dr Anthony Williams	St Georges, University of London
Professor Judy Buttriss	British Nutrition Foundation
Dr Harry Rutter	National Obesity Observatory
Dr Sian Robinson	MRC Southampton
Dr Susan Jebb	Food Network steering group Chair and MRC Human Nutrition Research, Cambridge

Secretariat

Dr Alison Tedstone	DH Nutrition Science
Gillian Swan	DH Diet and Nutrition Surveys
Dr Sheela Reddy	DH Nutrition Science
Rachel Elsom	DH Nutrition Science
Frederick Wheeler	DH Statistical Analyst
Dr Corinne Vaughan	DH Nutrition Delivery
Verity Kirkpatrick	DH Nutrition Science

Annex 2

Energy imbalance in the English population : estimated using adult height and weight measurements over a 10 year period

Summary

1. Using body weight measurements made in the Health Survey for England (HSE) in 1999 and 2009 weight gain was estimated for adults aged 20-40 years. Over the 10 year period the distribution of body weight shifted upwards by 6.2 kg at the median and 9 kg at the 90th percentile. Taking into account the inefficiency of conversion of food energy into stored energy, this equates to a positive energy imbalance of 16 and 24 kcal per day at the 50th and 90th percentiles.

Background

Health Survey for England

2. The HSE has been collected every year since 1994 to assess the health state of the country. The survey was commissioned originally by the Department of Health and, from April 2005 by the NHS Information Centre for health and social care. The HSE was designed to collect a representative sample of the country and was carried out by the National Centre for Social Research (NatCen) and the Department of Epidemiology and Public Health at the University College London Medical School (UCL).

3. For the analysis presented here, the 1999 and 2009 HSE datasets have been used to assess the population weight gain over a 10 year period. The surveys obtained 4645 adult respondents in 2009 and 7798 in 1999 and interviewers measured respondents heights and weights.

4. The 1999 survey did not include individual weightings as: 'The profile of the responding sample was judged to be sufficiently close to the estimated population distribution to make weighting unnecessary.'. The 2009 HSE survey did include sampling weights to rebalance the survey sample for age, gender and Government Office Region and so these weightings have been applied to the data in subsequent analyses.

Methods

Approach

5. This analysis follows a similar approach on English data as Hill et al [(2,3)] follow on USA data. Body weights values were extracted from HSE 1999 and 2009 datasets. The shift in weight over time was calculated by examining the relative difference in the same percentiles of the 1999 and 2009 weight distributions. The median shift, and the shift at the 90th percentile of the two weight distributions were estimated. For 20-40 year olds (the age range used by Hill et al [(2,3)]) 41-64 and 65-74 year olds.

Caveats and assumptions

6. The proportion of people who were underweight (ie removing those with BMI <18.5) were excluded from the analysis as arguably weight gain for underweight people is not undesirable.

7. The analysis did not adjust for the small average height gain (approx 1mm per year) seen in the England over the last 10 years (but neither does the Hill [(2,3)] analysis). Increases in height increase basal energy expenditure and hence total energy requirements, therefore, the 1mm increase in population height per year would reduce the energy gap, assuming the population BMI was maintained.

8. The HSE is a cross sectional survey therefore this analysis can provide an estimate for how the English population has gained weight over the 1999 to 2009 period assuming that other influences (such as migration rates into/out of England, death rates, or sampling) do not disproportionately affect the 1999 and 2009 surveys.

Calculation of the energy imbalance gap

9. It is recognised that 1lb (0.45kg) of weight gain is equivalent to 3500 kcal of extra stored energy. This conversion was used in this analysis to convert the weight gain of the population at the median and the 90th percentile into calories stored. Hill [(2,3)] refers to this as ‘Energy Accumulation’.

10. The body is not 100% efficient at converting excess energy consumed into stored bodyweight, therefore an efficiency factor was also applied. Hill [(2,3)] states a value of 50% efficiency, whereas other evidence and expert opinion puts the efficiency at higher than this. The Expert Group identified a value of 80% as the appropriate level of efficiency.

11. Applying this information to the assessment of weight gain can produce estimates of the extra calories being consumed by the population over time. The figures were then divided by the number of days over which weight was gained to give a daily figure. Hill [(2,3)] refers to this figure as the 'Energy Imbalance Gap'.

Hence: Energy gap = Energy Accumulation/Efficiency

12. SPSS 18 was used to select and analyse the data and the charts are presented in Excel.

Results

13. The following section is split in to the energy imbalance gap as determined for different age groups. The table below indicates the number of respondents used in the analysis.

Number of Adults	**1999**[c]	**2009**[c]	
Core Sample size	7798	4645	*weighted*
20-40 years[ab]	2651	1171	*1373*
41-64 years[a]	1925	1605	*1628*
65-74 years[a]	412	565	*421*

a Includes those with valid Measured height and weight, of BMI>=18.5

b Age rage used in Hill analysis

c Data are unweighted 1999, 2009 and weighted 2009 numbers.

Results for 20-40 year olds

14. Plotting the percentiles of the weight distribution of 20-40 year olds in 1999 and those in 2009 (see Figure 1 below) shows a clear increase across the population in weight over the last 10 years.

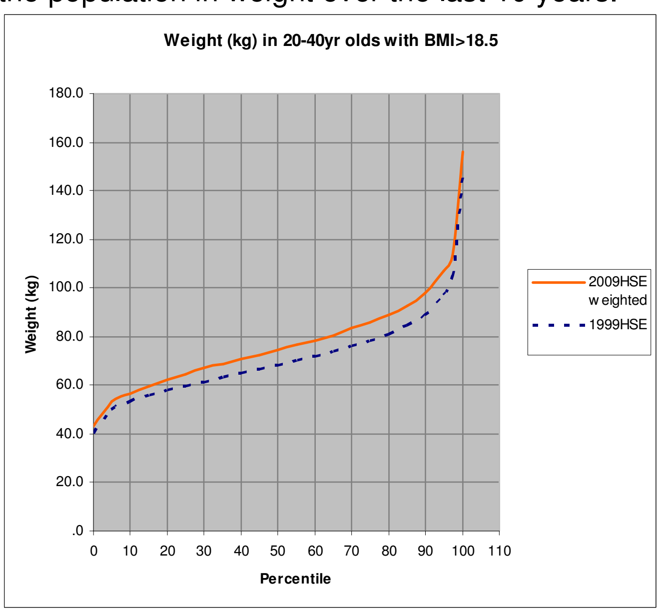

Figure 1: Percentiles of weight distribution of 20-40 year olds in 1999 and 2009.

15. Over 10 years, the shift in the median weight was a 6.2 kg increase, and at the 90th percentile the shift in weight was a 9.0 kg increase. Hence, on average this was an increase of 0.62kg per year for the median 20-40year old population or 0.9 kg per year at the 90th percentile of weights.

16. By applying the conversion of 1lb=3500kcal; 1kg=2.2lb, this equates to 13.1kcal per day Energy Accumulation at the median weight or 19 kcal per day Energy Accumulation for the 90th percentile.

17. Application of the 80% efficiency of the body to convert extra energy into extra body mass gave a calorie gain per day of 16.3 kcal per day at the median weight or 23.7 kcal per day at the 90th percentile.

The table below summarises the situation for 20-40year olds in 1999 and 2009.

	Difference in weight ***(kg in 10yrs)***	**Energy Accumulation** ***(kcal per day)***	**Energy Gap** ***(kcal per day)***	
			50%[a]	**80%[b]**
Median	6.2	13.1	26.2	16.3
90th Percentile	9	19.0	38.0	23.7

a Efficiency level as used by Hill

b Efficiency level as agreed by the Expert group on calorie reduction

18. Hence, for the English population of 20-40 year olds, a reduction of about 24 kcal per day would serve to prevent 90% of 20-40 year olds gaining further weight.

Results 41-64 year olds

19. The above assessment was also extended to 41 to 64 year olds and 65 to 74 year olds in 1999 and 2009. A similar weight distribution was seen in these age groups as in figure 1.

20. For 41 to 64 year olds, the shift in weight at the median was 6.9 kg in 10 years (equating to 18.3 kcal per day Energy Gap at 80% efficiency). At the 90th percentile of the weight distribution the change over 10 years was 10.7 kg (equating to 28.1 kcal per day Energy Gap at 80% efficiency).

The table below summarises the situation for 41-64year olds in 1999 and 2009.

	Difference in weight ***(kg in 10yrs)***	**Energy Accumulation** ***(kcal per day)***	**Energy Gap** ***(kcal per day)***	
			50%[a]	**80%[b]**
Median	6.9	14.6	29.2	18.3
90th Percentile	10.7	22.5	45.0	28.1

a Efficiency level as used by Hill

b Efficiency level as agreed by the Expert group on calorie reduction

21. Hence, for the English population of 41-64year olds, a reduction of about 28 kcal per day would serve to prevent 90% of 41-64year olds gaining further weight.

Results for 65-74 year olds

22. Similarly, for 65 to 74 year olds, the shift in weight at the median was 5.4 kg in 10 years (equating to 14.2 kcal per day Energy Gap at 80% efficiency). At the 90th percentile of the weight distribution the change over 10 years was 9.2 kg (equating to 24.2 kcal per day Energy Gap at 80% efficiency).

23. The table below summarises the situation for 65-74year olds in 1999 and 2009.

	Difference in weight ***(kg in 10yrs)***	**Energy Accumulation** ***(kcal per day)***	**Energy Gap** ***(kcal per day)***	
			50%[a]	**80%[b]**
Median	5.4	11.4	22.8	14.2
90th Percentile	9.2	19.3	38.7	24.2

a Efficiency level as used by Hill

b Efficiency level as agreed by the Expert group on calorie reduction

24. Hence for the English population of 65-74year olds, a reduction of about 24 kcal per day would serve to prevent 90% of 65-74year olds gaining further weight.

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