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This is an author produced version of a paper published in

International Journal of Obesity (ISSN 0307-0565, eISSN 1476-5497)

This version may not include final proof corrections and does not include published layout or pagination.

Citation Details

Citation for the version of the work held in 'OpenAIR@RGU':

GRYKA, A., BROOM, J, and ROLLAND, C., 2012. Global warming: is weight loss a solution? Available from *OpenAIR@RGU*. [online]. Available from: <http://openair.rgu.ac.uk>

Citation for the publisher's version:

GRYKA, A., BROOM, J, and ROLLAND, C., 2012. Global warming: is weight loss a solution? *International Journal of Obesity*, 36 (3), pp. 474-476.

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1 Title:

2 **Global warming: is weight loss a solution?**

3

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1 **Abstract**

2 The current climate change has been most likely caused by the increased
3 greenhouse gas emissions. We have looked at the major greenhouse gas, carbon
4 dioxide (CO₂), and estimated the reduction in the CO₂ emissions that would occur
5 with the theoretical global weight loss. The calculations were based on our
6 previous weight loss study, investigating the effects of a low-carbohydrate diet on
7 body weight, body composition and resting metabolic rate of obese volunteers
8 with type 2 diabetes. At 6 months we observed decreases in weight, fat mass, fat
9 free mass and CO₂ production. We estimated that a 10 kg weight loss of all obese
10 and overweight people would result in a decrease of 49.560 Mt of CO₂ per year,
11 which would equal to 0.2 % of the CO₂ emitted globally in 2007. This reduction
12 could help meet the CO₂ emission reduction targets and unquestionably would be
13 of a great benefit to the global health.

14

15 **Key words:** Global warming Carbon dioxide Obesity

16

1 **Introduction**

2 Climate change resulting from the mean rise in temperature over the last 100 years has
3 been widely discussed.¹ It has been accepted by the majority of scientists that the change
4 is being caused by the anthropogenic increase in greenhouse gas emissions. Greenhouse
5 gases in the atmosphere impair the earth's cooling processes which results in the global
6 rise in temperature.¹ The major greenhouse gas is carbon dioxide (CO₂) which mostly
7 comes from burning of fossil fuels (gas, oil, coal and other solid fuels). Other sources of
8 CO₂ emissions include iron and steel production, cement manufacture, solid waste
9 combustion, or petrochemical production. In 2007, burning of fossil fuels and cement
10 manufacture caused emission of 30649.36 Mt CO₂ globally.² Across the world, fossil
11 fuels are combusted to provide energy to generate electricity, for transport, business,
12 agriculture and industry. If the current emissions are not reduced, the global temperature
13 may rise by 2 to 7°C by the end of the century depending on the models used.³ This in
14 turn may cause the extinction of many species, irreversible changes in the ecosystems and
15 environmental disasters like storms, wildfires, droughts or floods. Such prognoses bring
16 governments to set targets for the reduction of CO₂ production and support the search for
17 alternative energy sources.

18

19 Humans, apart from indirectly producing CO₂ through the use of fossil fuels and the
20 industry, also produce CO₂ during respiration. Consequently, global CO₂ emissions
21 depend on the size of the population. In addition, due to the fact that CO₂ production is
22 proportionate to body mass, heavier individuals produce more (based on our data, for
23 every kg of body mass lost, RMR dropped by about 18 kcal/d and there was a 1%

1 reduction in CO₂ produced). The post-industrial changes to human lifestyle and diet have
2 resulted in an obesity epidemic. Although the knowledge of obesity mechanisms is
3 quickly expanding and novel obesity treatments are being developed, the situation on a
4 world population level has not improved. With the countless unsuccessful efforts to
5 tackle the obesity problem, it is more and more evident that the global modification of
6 today's lifestyles and environments may be the only possible solution to the obesity
7 epidemic.

8

9 In light of the growing literature on the link between obesity, type 2 diabetes, coronary
10 artery diseases and climate change ⁴⁻⁸ we thought it would be interesting to discuss the
11 effect of the global reduction of body mass, in particular of those individuals who are
12 obese and overweight on worldwide CO₂ emissions. It is clear that an omnipresent weight
13 loss of all obese and overweight population is as improbable in the short term as global
14 warming is inevitable if no action is taken. However, it is essential to model the effect of
15 population weight loss on CO₂ emissions. We have assumed a 10 kg weight loss based on
16 our observations as well as other studies using a low carbohydrate diet for a 6 month
17 period. ⁹

18

19 **Methods**

20 The calculations in the current paper are based on an observed decrease of resting
21 metabolic rate (RMR) that occurred with weight loss in our recent study. The intervention
22 involved 6 months on a low-carbohydrate, high-protein diet and included 25 obese
23 volunteers (13 females, 12 males) with poorly controlled (HBA_{1c} > 7.5%) type 2 diabetes

1 (T2DM) (ISRCTN20400186). CO₂ production and body composition were assessed at
2 baseline and 6 months. The CO₂ production was measured using the Quark RMR
3 (Cosmed, Rome, Italy). Body composition was measured by air-displacement
4 plethysmography (Bod Pod, Life Measurement Inc., Concord, California, USA). The
5 majority of the variables were not normally distributed, hence the Wilcoxon signed ranks
6 test was used to investigate 6-month changes in weight, fat mass (FM), fat free mass
7 (FFM) and CO₂ production. Analyses were performed with SPSS, version 17.0 (SPSS
8 Inc., Chicago, Illinois, USA).

9

10 **Results and calculations**

11 The dietary composition of participants on a low-carbohydrate / high-protein diet is
12 outlined in Table 1. As expected, the total energy of the diet was significantly lower
13 during the study than at baseline. According to our recommendations, the total amount of
14 carbohydrate, both as grams per day and as a percent of daily total energy, was lower
15 during the study than at baseline. Additionally, the amount of protein increased from 22%
16 to about 30% of total energy levels but did not change when expressed in grams per day.

17

18 After 6 months of the weight loss programme, we observed a decrease in weight, fat mass
19 (FM), fat free mass (FFM) and CO₂ production (Table 2). Six-month change in CO₂
20 production was positively correlated with changes in weight ($r = 0.506$; $P = 0.012$) and
21 FM ($r = 0.517$; $P = 0.011$). The majority of weight lost was attributed to a decrease in
22 FFM (Table 2), reflecting the higher protein content of the diet which was about 30% of
23 energy intake (Table 1). Weight loss achieved by implementing a normal- or a low-

1 protein diet (i.e. 10-15% of energy), could perhaps induce a higher loss of FFM than a
2 high-protein diet. Consequently, such a diet would cause an even bigger drop in RMR
3 and CO₂ production, but would not be beneficial to the health of the individual losing
4 weight.

5
6 On the basis of the current data, for every 1 kg of body mass lost, the CO₂ production
7 would decrease 3.2 ml/min. Therefore, an individual who lost 10 kg would produce 32 ml
8 of CO₂ less every minute. This would equal to 16812 l (33.04 kg) of CO₂ less in a year,
9 compared to what would be produced without weight loss. In 2008, the global number of
10 obese and overweight adults over 20 years old was 1.5 billion.¹⁰ If all those individuals
11 lost 10 kg and sustained it for a year, the reduction in CO₂ emissions would be 49.56 Mt
12 CO₂ /year. This would equate to 0.2% of CO₂ emitted globally in 2007 by burning of
13 fossil fuels and the manufacture of cement.² Analogously, a 5 kg weight loss of all
14 overweight and obese people would reduce global CO₂ emissions by only 0.1%.

15

16 **Discussion**

17 Our calculations have shown that a 10kg weight loss of all overweight and obese people
18 would translate into a 0.2 % reduction in the global CO₂ emissions. This percentage
19 seems small; however, we have looked at personal production only. Had we accounted
20 for additional reductions in CO₂ emissions that would likely accompany weight loss, for
21 example decreases in transport costs, and smaller amounts of food consumed as
22 suggested by Edwards and Roberts,¹¹ the total estimated decreases in CO₂ production
23 would have been greater. It could also be argued that the decrease in CO₂ production

1 which accompanies weight loss would mimic the benefits of decreasing global
2 population.

3
4 The theoretical global weight loss would also be of great health benefit; halving the risks
5 of developing T2DM and obesity-related cancers, improving glycaemic control in those
6 with T2DM, and finally improving blood pressure and lipid profiles.¹² Such changes
7 would bring the significant reductions of healthcare costs and also improvements in
8 general quality of life.

9
10 The targets for CO₂ emissions, as specified in the Kyoto Protocol Reference Manual, vary
11 for different countries and regions of the world. The UK Low Carbon Transition Plan
12 suggests lowering the emissions by 18% from the 2008 levels, or 95.9 Mt CO₂ / year, by
13 2020.¹³ A 10 kg weight loss of all overweight and obese in the UK would account for
14 over 1% of the CO₂ emission reduction target by 2020.¹⁴⁻¹⁶

15
16 This estimation was only possible when a number of assumptions were made. Firstly, we
17 assumed that weight loss in overweight people would result in the same change in FM
18 and CO₂ production as in the obese. Secondly, we assumed that obese and overweight but
19 otherwise healthy people would show the same change in CO₂ production with weight
20 loss as did obese people with type 2 diabetes. Finally, it has been shown that people with
21 type 2 diabetes have higher RMR than those without¹⁷ and therefore our calculations may
22 be slightly overestimated. However, if significant loss of FFM occurred with weight loss
23 (as may be the case with normal- or low-protein diets), the decrease in RMR could have

1 been higher, in which case the current estimations would underestimate it. Present
2 calculations were not designed to accurately reflect potential impact of global weight loss
3 on climate disruption, but to signal an opportunity for addressing individual, global and
4 environmental benefits of weight loss.

5

6 Health and climate change issues seem to be closely related in the perspective of our
7 future. We agree with Wilkinson et al (2010) who stated that policies to reduce carbon
8 emissions and climate change will improve health and well-being.¹⁸ The opposite should
9 also be true; tackling lifestyle-related health problems should have a positive effect on the
10 environment. Universal moderate weight loss of the overweight and obese would result in
11 an equivocal influence on the world carbon emissions with possible effects on climate
12 disruption. Nevertheless, this relatively small amount could help to meet the CO₂
13 emission reduction targets and unarguably would be of a great benefit to the human's
14 health. Moreover, the shift from seeing weight loss as beneficial for an individual's health
15 to also being beneficial for the planet may change attitudes toward healthy lifestyle. If
16 such benefits were persuasive to governments across the world, a significant impact on
17 global warming might be achieved as a consequence.

18

19 **Acknowledgements** We thank A. Stewart for reading of the manuscript and critical
20 comments. The study of low-carbohydrate diet was supported by the Go Lower company.

21 **Conflict of interest:** The authors declare no conflict of interest.

22

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4

1

2 **Table 1.** Changes in diet composition during the low-carbohydrate / high-protein weight

3

loss programme (n=25).

	Baseline	6 months	Change	P-value^a
Energy				
kcal	1845 ± 74	1194 ± 21	-594 ± 600	0.001
Carbohydrate				
g/day	164 ± 69	50 ± 25	-108 ± 74.1	< 0.001
% total energy	41 ± 9	22 ± 11	-17.8 ± 12.0	< 0.001
Protein				
g/day	87 ± 33	79 ± 28	-5.3 ± 32.2	0.882
% total energy	22 ± 7	30 ± 8	7.9 ± 7.5	< 0.001
Fat				
g/day	80 ± 44	68 ± 20	-16.4 ± 37.1	0.573
% total energy	38.5	50.0	10.0 ± 13.9	0.015

4 Values are expressed as mean ± standard deviation. ^aSignificance level of the difference

5 between baseline and 6 months, Wilcoxon signed ranks test.

1

2 **Table 2.** Changes in weight, fat mass, fat free mass, resting metabolic rate and CO₂

3 production, during the low-carbohydrate / high-protein weight loss programme (n=25).

	Baseline	6 months	Change	P-value ^a
Weight (kg)				
<i>Males (n=12)</i>	117.7 ± 19.5	108.0 ± 20.9	-9.7 ± 6.4	0.001
<i>Females (n=13)</i>	104.6 ± 22.2	94.2 ± 22.1	-10.4 ± 7.8	< 0.001
Total	110.9 ± 21.6	100.8 ± 22.2	-10.1 ± 7.0	<0.001
FM (kg)				
<i>males</i>	50.3 ± 13.0	41.1 ± 12.9	-9.2 ± 5.2	< 0.001
<i>females</i>	54.1 ± 17.6	45.7 ± 19.8	-8.8 ± 7.8	0.001
Total	52.4 ± 15.7	43.4 ± 16.5	-9.0 ± 6.5	< 0.001
FFM (kg)				
<i>males</i>		67.0 ± 12.0	-0.3 ± 1.7	0.266
<i>females</i>	67.3 ± 11.8	49.3 ± 7.3	-1.6 ± 1.4	< 0.001
Total	50.5 ± 7.4	58.1 ± 13.3	-0.9 ± 1.7	0.001
RMR (kcal/d)				
<i>males</i>	2267 ± 451	2033 ± 420	-234 ± 181	0.001
<i>females</i>	1845 ± 428	1572 ± 345	-274 ± 306	0.002
Total	2048 ± 81	1793 ± 442	-254 ± 250	< 0.001
CO₂ production (ml/min)				
<i>males</i>				
<i>females</i>	258 ± 56	220 ± 45	-37 ± 33	0.001
Total	201 ± 47	173 ± 42	-27 ± 37	0.013
	226 ± 58	195 ± 50	-31 ± 34	< 0.001

4 Values are expressed as mean ± standard deviation. Abbreviations: FM, fat mass; FFM,

5 fat free mass; RMR, resting metabolic rate; m, male; f, female. ^aSignificance level of the

6 difference between baseline and 6 months, Wilcoxon signed ranks test.