Weight Change Based on Net Calories

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1 Introduction

Many people throughout the world would like to either gain or lose weight. Having some idea of how much exercise is needed and how much food needs to be consumed to reach a goal weight would assist anybody with the goal of gaining or losing weight, but this is a tricky thing to predict. Our model question is “How do calories consumed, active calories burned and passive calories burned affect body weight”? Our model takes into consideration active calories burnt, which means the number of calories burnt from exercising by a person, passive calories burnt, which are the calories needed just to maintain body functions, and calories consumed to predict what a person’s body weight will look like over time, which will help out people with aspirations of reaching a certain body weight.

2 Assumptions and Justifications

1. People will gain/lose about the same amount of weight per calorie. Not everybody will lose the exact same weight per calorie burnt, but it will be approximately the same with a high sample size. [8]
2. Two people of the same sex and weight will passively burn approximately the same number of calories in the same time period. These are the two main factors in passive calories burnt, since a higher weight causes more calories to be consumed to uptake bodily functions and men and women have significantly different body compositions. [10]
3. Two people of the same weight will burn approximately the same number of calories if they do the same type of exercise for the same amount of type. A person’s body weight will cause them to have to strain more to exercise and therefore burn more calories, so it is a good variable to use to approximate calories burned in addition to the type of exercise. [6]
4. Somebody using the model will do approximately the same amount and type of exercise

per week throughout the model. If this wasn't consistent the model wouldn't work. If somebody wants to change their exercise habits, they can restart the model with their current weight.

5. Somebody using the model will consume approximately the same amount of calories per week throughout the model, for the same reason as number 4, if somebody wants to change this they can restart the model with their current weight.
6. Somebody using the model will most likely be overweight at the start. The model is made mostly for overweight people and our equations will fit better for that population.
7. Somebody using the model will be an adult. Most people attempting to watch their weight will be adults, since children have many more factors in weight change than fully grown adults.

3 Notations

-W_t: weight in kg by week (difference equation)

-h: height in cm (constant)

-Hr: hours

-MET: metabolic equivalent of task [6]

-Cn_t: Net calories (Cu_t - Cp_t - Ca_t) by week

-Cu_t: Calories consumed by week

-Cp_t: Passive calories used

-Ca_t: Active calories used

-W(t): weight in kilograms in terms of time (weeks) (continuous function)

4 Modeling and Analysis

4.1 Preliminary Model

Our starting model is a single difference equation we split up to compute easier.

$$Cp_t = \begin{bmatrix} Men: & 10.2 * W_t + 879 \\ Women: & 7.18 * W_t + 795 \end{bmatrix}$$

$$Ca_t = MET * (W_t * Hr_t)$$

$$Cn_t = Cu_t - Cp_t - Ca_t$$

$$W_{t+1} = W_t + (Cn_t/7700)$$

4.1.2 Formulas - Passive calories used

$$Cp_t = \begin{bmatrix} Men: & 10.2 * W_t + 879 \\ Women: & 7.18 * W_t + 795 \end{bmatrix}$$

This is our passive calories used equation. The equation uses the Owens Resting Energy Expenditure Equation (REE) [10] to calculate the daily passive calories used by a person at a certain weight and sex. We chose this formula since weight and sex are the two most important factors. Weight is important since a heavier person will have more to maintain. Sex is important since different sexes metabolise at different rates on average.

4.1.3 Formula - Active calories used

$$Ca_t = MET * (W_t * Hr_t)$$

This is our Active calories used equation. To calculate physical activity we decided to use the Metabolic equivalent of task which is a unit that measures how much energy a physical activity uses. [6] We found the equation from "Metabolic Equivalent in Adolescents, Active Adults and Pregnant Women" which is.

$$1MET = \frac{1Kcal}{W_t * Hr}$$

We can manipulate the equation to give us the calories used and by using the "The Compendium of Physical Activities Tracking Guide" we have a good gist of what the MET for each activity should be.

The Compendium of Physical Activities Tracking Guide

KEY
Blue text = new activity was added to the descritipon of that specific compendium code
If compcode and METS columns are blank under 1993 this means that the 2000 compcode and METS was**added** to the new addition to the compendium
If compcode and METS columns are blank under 2000 this means that the 1993 compcode and METS was**removed** from the new addition of the compendium

1993		2000			
compcode	**METS**	**compcode**	**METS**	**heading**	**description**
01009	8.5	01009	8.5	bicycling	bicycling, BMX or mountain
01010	4.0	01010	4.0	bicycling	bicycling, <10 mph, leisure, to work or for pleasure (Taylor Code 115
		01015	8.0	bicycling	bicycling, general
01020	6.0	01020	6.0	bicycling	bicycling, 10-11.9 mph, leisure, slow, light effort
01030	8.0	01030	8.0	bicycling	bicycling, 12-13.9 mph, leisure, moderate effort
01040	10.0	01040	10.0	bicycling	bicycling, 14-15.9 mph, racing or leisure, fast, vigorous effor
01050	12.0	01050	12.0	bicycling	bicycling, 16-19 mph, racing/not drafting or >19 mph drafting, very fast, racing genera
01060	16.0	01060	16.0	bicycling	bicycling, >20 mph, racing, not drafting
01070	5.0	01070	5.0	bicycling	unicycling
02010	5.0	02010	7.0	conditioning exercise	bicycling, stationary, general
02011	3.0	02011	3.0	conditioning exercise	bicycling, stationary, 50 watts, very light effor
02012	5.5	02012	5.5	conditioning exercise	bicycling, stationary, 100 watts, light effor
02013	7.0	02013	7.0	conditioning exercise	bicycling, stationary, 150 watts, moderate effor

Table 1 (a piece of The Compendium of Physical Activities Tracking Guide)

4.1.4 Formula - Net Calories

$$Cn_t = Cu_t - Cp_t - Ca_t$$

This is a formula for the net calories we have at time t. It's the difference between the calories we take in and the calories we use up both passively and actively. If the net is positive it will cause weight gain, if it is negative it will cause weight loss and if it is 0 then weight will be maintained.

4.1.5 Formula - Weight

$$W_{t+1} = W_t + (Cn_t/7700)$$

This calculates the new weight we will have at the next time step, which we did in weeks. The new weight is the sum of our current weight and how much weight we lost or gained during that time step. We calculate how much we lost or gained by dividing our net calories by 7700kcal. If the net calories are positive then weight will increase, but if the net calories are negative weight will be lost.

The conversion number 7700 is a widely spread amount for how much kcal is in 1kg of body weight. It comes from the Wishnofsky's rule which calculate it by assuming that the person body composition was 79% fat mass (FM) and 21% fat-free mass (FFM) which is that of an overweight person for simplicity sake we decided to just use the constant 7700 instead of the equation since most people using this equation are probably overweight looking to lose weight and most of data is studying overweight people.

4.1.6 General Solution and Model Stability

The men's general solution:

$$(\frac{1}{7700} * (7689.8 - MET * Hr_t))^t * (\frac{W(0) - (\frac{Cu_t - 879}{7700})}{1 - (\frac{1}{7700} * (7689.8 - MET * Hr_t))}) + (\frac{\frac{Cu_t - 879}{7700}}{1 - (\frac{1}{7700} * (7689.8 - MET * Hr_t))})$$

The women's general solution:

$$(\frac{1}{7700} * (7692.82 - MET * Hr_t))^t * (\frac{W(0) - (\frac{Cu_t - 795}{7700})}{1 - (\frac{1}{7700} * (7692.82 - MET * Hr_t))}) + (\frac{\frac{Cu_t - 795}{7700}}{1 - (\frac{1}{7700} * (7692.82 - MET * Hr_t))})$$

The general solutions show that the equations are technically sensitive to initial conditions. If MET*Hrt is greater than 15,389.8 for men and greater than 15,392.82 for women, the model will be unstable, but it is impossible for MET*Hrt to be that high, so the model is stable. The model will approach:

For men:

$$(\frac{\frac{Cu_t - 879}{7700}}{1 - (\frac{1}{7700} * (7689.8 - MET * Hr_t))})$$

For women:

$$(\frac{\frac{Cu_t - 795}{7700}}{1 - (\frac{1}{7700} * (7692.82 - MET * Hr_t))})$$

4.2 Testing Our Model:

Due to it being difficult to find data that tracks a single individuals weight loss over a course of time, we decided to try to replicate diet weight loss studies we found that gave us the caloric intake, mean baseline

weight and mean end of treatment weight the group they were looking at had with our own model and try to stay within the standard deviation of those studies results.

4.2.1 Viegener study:

The first study we decided to run was the Viegener study which was part of the set of very low calorie studies reviewed in "Obesity: Identification, Assessment and Management of Overweight and Obesity in Children, Young People and Adults: Partial Update of CG43". The study was focusing on the effects of a very low calorie diet(VLCD) of 800kcal/day for 4 days a week and 1200kcal/day for 3 days a week plus 30 mins a day conditional exercise for 6 days a week in an group of all overweight women, compared to the control group of who where on a 1200kcal/day and the same exercise regiment for the whole 26 week treatment. The paper provided the following tables which state the starting condition of the study and the end results. We will try to model both the standard diet and the VLCD diet with our model..

Viegener 1990[64]	**Treatment (6 months)** Behavioural therapy + exercise + diet (intermittent diet, n= 42): • VLCD - 800 kcal/day, low fat diet, used 4 days a week (3 days: 1200 kcal/day) Behavioural therapy + exercise + diet (standard deficit diet, N= 43) • 1200 kcal/day Treatment also included exercise component (i.e. programmed aerobic exercise, target goal 30 minutes per day, 6 days a week) During treatment, participants received 26 weekly group sessions, each 2 hours in duration **Weight maintenance (6 months)** During maintenance, participants undertook therapist-led "maintenance" sessions, held twice a month	Females, 21-59 years of age, 25-99% overweight (based on the height-weight tables of the Metropolitan Life Insurance Company, 1983) Initial weight: Treatment 98.6 kg (15.9) Comparator 94.6 kg (12.6)	Withdrawals Weight in kg, change (start of study to end of VLCD period) Weight in kg, change (start of study to end of maintenance period)	All female sample Difference in baseline weight Intermittent VLCD

Table 2 (Table 8 in Obesity: Identification, Assessment and Management of Overweight and Obesity in Children, Young People and Adults: Partial Update of CG43[5])

Study	Mean kg – baseline	Mean kg – end of VLCD period	Mean kg – end of weight maintenance period
Pavlou 1989	VLCD: 101.9 kg (4.585) LCD: 101.5 kg (3.853)	8 weeks: Unable to extract data from graph	18 months: VLCD: 89.8 kg (5.56) LCD: 90.77 kg (4.281)
Simonen 2000	Overall: 93.2 kg (3.7)	12 weeks: Unable to extract data from paper	24 months: Overall: 87.2 kg (3.2)
Viegener 1990	VLCD: 94.6 kg (12.6) Standard diet: 98.6 kg (15.9)	26 weeks: VLCD: -10.2 kg (5.1) [84.4 kg] Standard diet: -8.9 kg (5.6) [89.7 kg]	12 months: VLCD: -9.0 kg (6.7) [85.6 kg] Standard diet: -8.9 kg (7.3) [89.7 kg]
Wadden 1994	VLCD: 107.85 kg (14.89 Standard diet: 105.43 kg (13.68)	17 weeks: VLCD: -20.50 kg (7.29) [87.35 kg] Standard diet: -9.14 kg (6.17) [96.29 kg]	18 months: VLCD: -10.94 kg (9.97) [96.91kg] Standard diet: -12.18 kg (8.23) [93.25 kg]
Wing 1984	VLCD: 91.8 kg (13.4) Standard diet: 92.9 kg (18.5)	10 weeks: VLCD: -8.4 kg (1.4) [90.96 kg] Standard diet: -7.8 kg (1.5) [85.1 kg]	12 months: VLCD: -2.7 kg (2.4) [89.1 kg] Standard diet: -3.0 kg (2.3) [89.9 kg]
Wing 1991	VLCD: 102.1 kg (11.7) Standard diet: 104.5 kg (21.5)	20 weeks: VLCD: 83.5 kg (9.5) Standard diet: 94.4 kg (19.8)	12 months: VLCD: 93.5 kg (10.4) Standard diet: 97.7 kg (17.4)
Wing 1994	VLCD: 105.8 kg (19.4) Standard diet: 107.7 kg (18.7)	52 weeks: VLCD: -14.2 kg (10.3) [91.6 kg] Standard diet:-10.5 kg (11.6) [97.5 kg]	24 months: VLCD: -7.2 kg (8.0) [98.6 kg] Standard diet: -5.7 kg (7.9) [102 kg]

Table 3 (Table 9 of Obesity: Identification, Assessment and Management of Overweight and Obesity in Children, Young People and Adults: Partial Update of CG43[5])

4.2.1.1 Standard diet model:

We first looked to replicate the results of the standard diet. We used the mean kg baseline weight given (see table 3) as our initial value for W0 = 98.6, The standard diet calorie intake of 1200kcal/day (see table 2) multiplied by 7 for our weekly calorie intake so Cu0 = 8400kcal and for our MET we just assumed the lowest level of conditioning exercise on the chart which was 3(see table 1) and The exercised for 3 hours a week(table 2)

eeks	MET	Hours active	Calories in:	Active Calories:	Net Calories:	Weight	Daily Change	Percent Change	Passive Calorie
0	3	3	8400	887.4	-3435.96	98.6			10948.56
1	3	3	8400	883.3839429	-3407.579863	98.15377143	-0.4462285714	-0.4525644741	10924.19592
2	3	3	8400	879.4010573	-3379.434138	97.71122859	-0.4425428393	-0.4508668723	10900.03308
3	3	3	8400	875.4510693	-3351.52089	97.27234104	-0.4388875504	-0.4491679787	10876.06982
4	3	3	8400	871.5337073	-3323.838198	96.83707859	-0.4352624533	-0.4474678502	10852.30449
5	3	3	8400	867.6487016	-3296.384158	96.40541129	-0.4316672984	-0.4457665439	10828.73546
6	3	3	8400	863.795785	-3269.156881	95.97730945	-0.4281018387	-0.4440641173	10805.3611
7	3	3	8400	859.9746926	-3242.154494	95.55274362	-0.4245658287	-0.4423606279	10782.1798
8	3	3	8400	856.1851614	-3215.37514	95.13168459	-0.4210590252	-0.4406561332	10759.18998
9	3	3	8400	852.4269307	-3188.816977	94.71410341	-0.417581187	-0.4389506912	10736.39005
10	3	3	8400	848.699742	-3162.478177	94.29997133	-0.4141320749	-0.4372443596	10713.77843
11	3	3	8400	845.0033389	-3136.356928	93.88925988	-0.4107114515	-0.4355371966	10691.35359
12	3	3	8400	841.3374672	-3110.451435	93.4819408	-0.4073190816	-0.4338292603	10669.11397
13	3	3	8400	837.7018746	-3084.759914	93.07798607	-0.4039547318	-0.4321206089	10647.05804
14	3	3	8400	834.0963111	-3059.280598	92.6773679	-0.4006181706	-0.4304113008	10625.18429
15	3	3	8400	830.5205286	-3034.011735	92.28005873	-0.3973091686	-0.4287013945	10603.49121
16	3	3	8400	826.9742811	-3008.951586	91.88603123	-0.3940274981	-0.4269909485	10581.97731
17	3	3	8400	823.4573247	-2984.098428	91.4952583	-0.3907729333	-0.4252800214	10560.6411
18	3	3	8400	819.9694174	-2959.45055	91.10771305	-0.3875452503	-0.4235686718	10539.48113
19	3	3	8400	816.5103194	-2935.006257	90.72336882	-0.3843442272	-0.4218569585	10518.49594
20	3	3	8400	813.0797926	-2910.763868	90.34219918	-0.3811696438	-0.4201449403	10497.68407
21	3	3	8400	809.677601	-2886.721714	89.96417789	-0.3780212815	-0.4184326759	10477.04411
22	3	3	8400	806.3035107	-2862.878143	89.58927897	-0.3748989239	-0.4167202243	10456.57463
23	3	3	8400	802.9572895	-2839.231513	89.21747661	-0.3718023562	-0.4150076443	10436.27422
24	3	3	8400	799.6387072	-2815.780198	88.84874525	-0.3687313653	-0.4132949947	10416.14149
25	3	3	8400	796.3475356	-2792.522585	88.48305951	-0.36568574	-0.4115823346	10396.17505
26	3	3	8400	793.0835481	-2769.457074	88.12039424	-0.3626652707	-0.4098697228	10376.37353

At the end of the 26 week treatment our model predicts that we should have went from the baseline weight of 98.6kg to the final weight of 88.12039424kg a weight loss of 10.47960576 kg which is with in the studies weight loss range of 8.9kg lost with an SD of 5.6 kg (table 3).

4.2.1.2 VLCD:

We first looked to replicate the results of the VLCD. We used the mean kg baseline weight given (table 3) as our initial value for W0 = 94.6, The VLCD calorie intake is 800kcal/day for 4 days a week and 1200kcal/day for 3 day a week (table 1) making a total weekly calorie intake of Cu0 = 6800kcal and for our MET we just assumed the lowest level of conditional exercise on the chart which was 3(table 1) and The exercised for 3 hours a week so Hr =3 (table 2)

weeks	MET	Hours active	Calories in:	Active Calories:	Net Calories:	Weight	Daily Change	Percent Change	Passive Calorie
0	3	3	6800	851.4	-4781.56	94.6			10730.16
1	3	3	6800	845.8111636	-4742.065556	93.97901818	-0.6209818182	-0.6564289833	10696.25439
2	3	3	6800	840.2684896	-4702.897327	93.36316551	-0.6158526697	-0.6553086865	10662.62884
3	3	3	6800	834.7715966	-4664.052616	92.75239963	-0.6107658866	-0.6541829245	10629.28102
4	3	3	6800	829.3201066	-4625.528753	92.14667851	-0.605721119	-0.6530516962	10596.20865
5	3	3	6800	823.9136444	-4587.323087	91.54596049	-0.6007180199	-0.6519150007	10563.40944
6	3	3	6800	818.5518382	-4549.43299	90.95020424	-0.5957562451	-0.6507728379	10530.88115
7	3	3	6800	813.2343191	-4511.855855	90.35936879	-0.5908354532	-0.6496252077	10498.62154
8	3	3	6800	807.9607213	-4474.589097	89.77341348	-0.5859553058	-0.6484721105	10466.62838
9	3	3	6800	802.7306821	-4437.630154	89.19229802	-0.5811154672	-0.6473135471	10434.89947
10	3	3	6800	797.5438417	-4400.976481	88.61598241	-0.5763156044	-0.6461495187	10403.43264
11	3	3	6800	792.3998432	-4364.625559	88.04442702	-0.5715553872	-0.6449800269	10372.22572
12	3	3	6800	787.2983328	-4328.574885	87.47759254	-0.5668344881	-0.6438050735	10341.27655
13	3	3	6800	782.2389596	-4292.821981	86.91543995	-0.5621525825	-0.642624661	10310.58302
14	3	3	6800	777.2213754	-4257.364386	86.35793061	-0.5575093482	-0.6414387921	10280.14301
15	3	3	6800	772.2452353	-4222.199662	85.80502614	-0.5529044658	-0.6402474699	10249.95443
16	3	3	6800	767.3101967	-4187.32539	85.25668852	-0.5483376185	-0.639050698	10220.01519
17	3	3	6800	762.4159203	-4152.73917	84.71288003	-0.5438084922	-0.6378484804	10190.32325
18	3	3	6800	757.5620693	-4118.438623	84.17356325	-0.5393167753	-0.6366408215	10160.87655
19	3	3	6800	752.7483098	-4084.42139	83.63870109	-0.5348621588	-0.6354277259	10131.67308
20	3	3	6800	747.9743108	-4050.68513	83.10825676	-0.5304443363	-0.6342091991	10102.71082
21	3	3	6800	743.2397438	-4017.227523	82.58219375	-0.5260630039	-0.6329852465	10073.98778
22	3	3	6800	738.544283	-3984.046267	82.06047589	-0.5217178601	-0.6317558742	10045.50198
23	3	3	6800	733.8876056	-3951.13908	81.54306729	-0.5174086061	-0.6305210888	10017.25147
24	3	3	6800	729.2693911	-3918.503697	81.02993234	-0.5131349454	-0.6292808971	9989.234306
25	3	3	6800	724.6893218	-3886.137874	80.52103576	-0.508896584	-0.6280353066	9961.448552
26	3	3	6800	720.1470828	-3854.039385	80.01634253	-0.5046932304	-0.6267843249	9933.892302

At the end of the 26 week treatment our model predicts that we should have went from the baseline weight of 94.6kg to the final weight of 80.01634253kg a weight loss of 14.58365747kg which is with in the studies weight loss range of 10.2kg lost with an SD of 5.1 kg(table 3)

4.2.2 Caloric restriction model:

The next study we looked at was focusing on how much weight can be lost in a group of overweight people, majority female, if they went on a 500 caloric deficit a day diet for 14 weeks of treatment. To model the study we use the mean baseline weight of 99.3kg as our W0 and since this study is about

having a 500 calorie deficit each day we can ignore our Cu,Cp,Ca,MET,Hr variables and just set Cn to -3500(the caloric deficit for each week,500 kcal/day *7) for the duration of the treatment.[2]

days	MET	Hours active	Calories in:	Active Calories:	Net Calories:	Weight	Daily Change	Percent Change	Passive Calorie
0	0	0	0	0	-3500	99.3			0
1	0	0	0	0	-3500	98.84545455	-0.4545454545	-0.4577497025	0
2	0	0	0	0	-3500	98.39090909	-0.4545454545	-0.4598546859	0
3	0	0	0	0	-3500	97.93636364	-0.4545454545	-0.4619791185	0
4	0	0	0	0	-3500	97.48181818	-0.4545454545	-0.4641232711	0
5	0	0	0	0	-3500	97.02727273	-0.4545454545	-0.4662874196	0
6	0	0	0	0	-3500	96.57272727	-0.4545454545	-0.4684718448	0
7	0	0	0	0	-3500	96.11818182	-0.4545454545	-0.4706768333	0
8	0	0	0	0	-3500	95.66363636	-0.4545454545	-0.4729026766	0
9	0	0	0	0	-3500	95.20909091	-0.4545454545	-0.4751496721	0
10	0	0	0	0	-3500	94.75454545	-0.4545454545	-0.4774181228	0
11	0	0	0	0	-3500	94.3	-0.4545454545	-0.4797083373	0
12	0	0	0	0	-3500	93.84545455	-0.4545454545	-0.4820206305	0
13	0	0	0	0	-3500	93.39090909	-0.4545454545	-0.4843553231	0
14	0	0	0	0	-3500	92.93636364	-0.4545454545	-0.4867127421	0

At the end of the 14 week treatment our model predicts that we should have went from the baseline weight of 99.3kg to the final weight of 92.93636364kg a weight loss of 6.36363636kg which is with in the studies weight loss range of 4.8kg lost with an SD of 5.2 kg.[2]

4.2.3 Wing 1994

The last study we tried to test with also came from the “ Obesity: Identification, Assessment and Management of Overweight and Obesity in Children, Young People and Adults: Partial Update of CG43”. This study also focuses on a VLCD diet and compares it to a standard diet, except with this diet they

alternate between intaking 400-500kcal/day to 1000-1200kcal/day for the duration of the 52 week treatment. The below table shows the conditions of the study.

Wing 1994[67]	**Treatment 50 weeks** Behavioural therapy + diet (N= 48) • 1000-1200 kcal/d Behavioural therapy + VLCD (N= 45) • Week 1-12: 400-500 kcal/d • Week 13-23: increase to 1000-1200 kcal/d • Week 24-36: 400-500 kcal/d • Week 37-48: increase to 1000-1200 kcal/d Behavioural treatment (weekly group meetings) occurred over 1 year. Meetings consisted of individual weigh-in, review of self-monitoring records, and a lecture and discussion concerning a topic related to nutrition, exercise or behaviour modification.	Obese patients with T2D (diagnosis of diabetes for an average of 6.8 years [SD 6.2]) Initial weight: VLCD 105.8 kg (19.4) 37.42 BMI (6.13) Standard dietary advice 107.7 kg (18.7) 38.31 BMI (6.52)	Withdrawals Weight in kg, change (start of study to end of VLCD period) Weight in kg, change (start of study to end of maintenance period) Weight in BMI, change (start of study to end of VLCD period)

Table 4 (Table 8 in Obesity: Identification, Assessment and Management of Overweight and Obesity in Children, Young People and Adults: Partial Update of CG43)[5]

4.2.3.1 Standard diet

We first looked to replicate the results of the standard diet. We used the mean kg baseline weight given (table 3) as our initial value for W0 = 107.2, The standard diet calorie intake of 1200kcal/day (see table 4) multiplied by 7 for our weekly calorie intake so Cu0 = 8400 kcal and for our MET and Hr since it wasn't specified if the participants did any exercise we will set those to 0.

standard weeks	MET	Hours active	Calories in:	Active Calories:	Net Calories:	Weight	Daily Change	Percent Change	Passive Calorie
1	0	0	8400	0	-3045.42	107.7			11445.42
2	0	0	8400	0	-3023.825204	107.3044909	-0.3955090909	-0.3672322107	11423.8252
3	0	0	8400	0	-3002.383534	106.9117863	-0.3927045719	-0.3659721681	11402.38353
4	0	0	8400	0	-2981.093905	106.5218664	-0.3899199395	-0.3647118366	11381.09391
5	0	0	8400	0	-2959.955239	106.1347113	-0.3871550526	-0.3634512478	11359.95524
6	0	0	8400	0	-2938.966466	105.7503016	-0.3844097714	-0.3621904337	11338.96647
7	0	0	8400	0	-2918.126522	105.3686176	-0.3816839566	-0.3609294261	11318.12652
8	0	0	8400	0	-2897.434352	104.9896401	-0.3789774704	-0.359668257	11297.43435
9	0	0	8400	0	-2876.888908	104.61335	-0.3762901756	-0.3584069581	11276.88891
10	0	0	8400	0	-2856.489151	104.239728	-0.3736219362	-0.3571455615	11256.48915
11	0	0	8400	0	-2836.234046	103.8687554	-0.370972617	-0.3558840991	11236.23405
12	0	0	8400	0	-2816.122568	103.5004133	-0.3683420839	-0.3546226027	11216.12257
13	0	0	8400	0	-2796.153699	103.1346831	-0.3657302036	-0.3533611044	11196.1537
14	0	0	8400	0	-2776.326427	102.7715463	-0.363136844	-0.3520996361	11176.32643
15	0	0	8400	0	-2756.639749	102.4109844	-0.3605618737	-0.3508382297	11156.63975
16	0	0	8400	0	-2737.092667	102.0529793	-0.3580051622	-0.3495769172	11137.09267
17	0	0	8400	0	-2717.684192	101.6975127	-0.3554665801	-0.3483157305	11117.68419
18	0	0	8400	0	-2698.41334	101.3445667	-0.3529459989	-0.3470547014	11098.41334
19	0	0	8400	0	-2679.279137	100.9941234	-0.3504432909	-0.3457938619	11079.27914
20	0	0	8400	0	-2660.280612	100.6461651	-0.3479583294	-0.3445332439	11060.28061
21	0	0	8400	0	-2641.416804	100.3006741	-0.3454909885	-0.3432728792	11041.4168
22	0	0	8400	0	-2622.686757	99.95763292	-0.3430411434	-0.3420127996	11022.68676
23	0	0	8400	0	-2604.089524	99.61702425	-0.3406086698	-0.3407530369	11004.08952
24	0	0	8400	0	-2585.624162	99.2788308	-0.3381934447	-0.3394936229	10985.62416
25	0	0	8400	0	-2567.289736	98.94303546	-0.3357953457	-0.3382345894	10967.28974
26	0	0	8400	0	-2549.085318	98.60962121	-0.3334142514	-0.3369759679	10949.08532
27	0	0	8400	0	-2531.009986	98.27857117	-0.3310500413	-0.3357177902	10931.00999
28	0	0	8400	0	-2513.062824	97.94986857	-0.3287025955	-0.3344600879	10913.06282
29	0	0	8400	0	-2495.242924	97.62349678	-0.3263717953	-0.3332028925	10895.24292
30	0	0	8400	0	-2477.549383	97.29943925	-0.3240575226	-0.3319462356	10877.54938
31	0	0	8400	0	-2459.981306	96.97767959	-0.3217596602	-0.3306901485	10859.98131
32	0	0	8400	0	-2442.537802	96.6582015	-0.3194780917	-0.3294346627	10842.5378
33	0	0	8400	0	-2425.217988	96.3409888	-0.3172127016	-0.3281798095	10825.21799
34	0	0	8400	0	-2408.020988	96.02602542	-0.3149633751	-0.3269256202	10808.02099
35	0	0	8400	0	-2390.94593	95.71329543	-0.3127299985	-0.3256721259	10790.94593
36	0	0	8400	0	-2373.99195	95.40278297	-0.3105124585	-0.3244193579	10773.99195
37	0	0	8400	0	-2357.158189	95.09447232	-0.3083106429	-0.3231673472	10757.15819
38	0	0	8400	0	-2340.443794	94.78834788	-0.3061244401	-0.3219161247	10740.44379
39	0	0	8400	0	-2323.84792	94.48439414	-0.3039537395	-0.3206657214	10723.84792
40	0	0	8400	0	-2307.369726	94.18259571	-0.3017984312	-0.3194161681	10707.36973
41	0	0	8400	0	-2291.008377	93.88293731	-0.299658406	-0.3181674955	10691.00838
42	0	0	8400	0	-2274.763045	93.58540375	-0.2975335555	-0.3169197343	10674.76304
43	0	0	8400	0	-2258.632907	93.28997998	-0.2954237721	-0.315672915	10658.63291
44	0	0	8400	0	-2242.617146	92.99665103	-0.293328949	-0.3144270682	10642.61715
45	0	0	8400	0	-2226.714952	92.70540205	-0.29124898	-0.3131822241	10626.71495
46	0	0	8400	0	-2210.925519	92.41621829	-0.28918376	-0.3119384131	10610.92552
47	0	0	8400	0	-2195.248047	92.12908511	-0.2871331842	-0.3106956653	10595.24805
48	0	0	8400	0	-2179.681743	91.84398796	-0.2850971489	-0.3094540108	10579.68174
49	0	0	8400	0	-2164.225817	91.56091241	-0.283075551	-0.3082134795	10564.22582
50	0	0	8400	0	-2148.879489	91.27984412	-0.281068288	-0.3069741013	10548.87949
51	0	0	8400	0	-2133.64198	91.00076886	-0.2790752583	-0.3057359059	10533.64198
52	0	0	8400	0	-2118.512518	90.7236725	-0.277096361	-0.3044989229	10518.51252

At the end of the 52 week treatment our model predicts that we should have went from the baseline weight of 107.2kg to the final weight of 90.7236725kg a weight loss of 16.4763275kg which is with in the studies weight loss range of 10.5kg lost with an SD of 11.6 kg(table 3).

4.2.3.2 vlcd

We first looked to replicate the results of the VLCD. We used the mean kg baseline weight given (105.8kg) as our initial value for W0 = 105.8, The VLCD calorie intake is 400-500kcal/day for the first 12 weeks then 1000-1200kcal/day for the next 11 weeks then back to 400-500kcal for the next 13 weeks than 1000-1200kcal/day for the rest of the treatment(table 4) we will set our Cut to the value for each week; and for our MET and Hr since it wasn't specified if the participants did any exercise we will set those to 0.

weeks	MET	Hours active	Calories in:	Active Calories:	Net Calories:	Weight	Daily Change	Percent Change	Passive Calorie
1	0	3	3500	0	-7836.22	105.7			11336.22
2	0	3	3500	0	-7780.654076	104.6823091	-1.017690909	-0.9628106992	11280.65408
3	0	3	3500	0	-7725.482166	103.6718345	-1.010474555	-0.9652772891	11225.48217
4	0	3	3500	0	-7670.701474	102.6685252	-1.003309372	-0.9677743011	11170.70147
5	0	3	3500	0	-7616.309227	101.6723302	-0.9961949986	-0.9703022373	11116.30923
6	0	3	3500	0	-7562.302671	100.6831991	-0.9891310685	-0.9728616103	11062.30267
7	0	3	3500	0	-7508.67907	99.70108187	-0.98211723	-0.9754529443	11008.67907
8	0	3	3500	0	-7455.435709	98.72592874	-0.975153126	-0.9780767748	10955.43571
9	0	3	3500	0	-7402.569892	97.75769034	-0.9682384038	-0.9807336493	10902.56989
10	0	3	3500	0	-7350.078942	96.79631783	-0.9613727133	-0.9834241275	10850.07894
11	0	3	3500	0	-7297.960201	95.84176192	-0.9545557068	-0.9861487815	10797.9602
12	0	3	3500	0	-7246.211028	94.89397488	-0.9477870391	-0.9889081963	10746.21103
13	0	3	8400	0	-2294.828805	93.95290851	-0.9410663673	-0.9917029701	10694.8288
14	0	3	8400	0	-2278.556382	93.6548788	-0.2980297149	-0.3172118028	10678.55638
15	0	3	8400	0	-2262.399346	93.35896238	-0.2959164133	-0.3159647603	10662.39935
16	0	3	8400	0	-2246.356878	93.06514429	-0.2938180989	-0.314718683	10646.35688
17	0	3	8400	0	-2230.428166	92.77340983	-0.2917346595	-0.3134736014	10630.42817
18	0	3	8400	0	-2214.612402	92.48374383	-0.2896659955	-0.3122295458	10614.6124
19	0	3	8400	0	-2198.908787	92.19613163	-0.2876120003	-0.3109865464	10598.90879
20	0	3	8400	0	-2183.316525	91.91055906	-0.2855725698	-0.3097446332	10583.31652
21	0	3	8400	0	-2167.834826	91.62701146	-0.2835476006	-0.3085038362	10567.83483
22	0	3	8400	0	-2152.462906	91.34547447	-0.2815369904	-0.3072641854	10552.46291
23	0	3	8400	0	-2137.199987	91.06593383	-0.2795406372	-0.3060257104	10537.19999
24	0	3	3500	0	-7022.045297	90.78837539	-0.2775584399	-0.3047884409	10522.0453
25	0	3	3500	0	-6972.252612	89.87642146	-0.9119539346	-1.004483152	10472.25261
26	0	3	3500	0	-6922.813002	88.97093411	-0.9054873522	-1.007480424	10422.813
27	0	3	3500	0	-6873.723985	88.07186748	-0.8990666237	-1.010517235	10373.72396
28	0	3	3500	0	-6824.983013	87.17917606	-0.892691424	-1.013594295	10324.98301
29	0	3	3500	0	-6776.587679	86.29281463	-0.8863614302	-1.016712328	10276.58768
30	0	3	3500	0	-6728.535512	85.41273831	-0.8800763219	-1.019872078	10228.53551
31	0	3	3500	0	-6680.824078	84.53890253	-0.8738357807	-1.023074307	10180.82408
32	0	3	3500	0	-6633.450982	83.67126304	-0.8676394906	-1.026319794	10133.45096
33	0	3	3500	0	-6586.413784	82.8097759	-0.8614871379	-1.029609339	10086.41376
34	0	3	3500	0	-6539.710103	81.95439749	-0.8553784109	-1.032943758	10039.7101
35	0	3	3500	0	-6493.337613	81.10508449	-0.8493130004	-1.03632389	9993.337613
36	0	3	3500	0	-6447.293946	80.26179389	-0.8432905991	-1.039750596	9947.293946
37	0	3	8400	0	-1501.576771	79.42448299	-0.8373109021	-1.043224754	9901.576771
38	0	3	8400	0	-1490.929227	79.22947302	-0.1950099703	-0.2455287878	9890.929227
39	0	3	8400	0	-1480.357183	79.03584584	-0.1936271723	-0.2443878079	9880.357183
40	0	3	8400	0	-1469.860105	78.84359166	-0.1922541796	-0.2432493479	9869.860105
41	0	3	8400	0	-1459.43746	78.65270074	-0.1908909227	-0.2421134282	9859.43746
42	0	3	8400	0	-1449.088722	78.46316341	-0.1895373325	-0.240980069	9849.088722
43	0	3	8400	0	-1438.813386	78.27497007	-0.1881933405	-0.2398492902	9838.813386
44	0	3	8400	0	-1428.610871	78.08811119	-0.1868588787	-0.2387211116	9828.610871
45	0	3	8400	0	-1418.480721	77.90257731	-0.1855338793	-0.2375955527	9818.480721
46	0	3	8400	0	-1408.422403	77.71835903	-0.1842182755	-0.2364726327	9808.422403
47	0	3	8400	0	-1398.435408	77.53544703	-0.1829120004	-0.2353523707	9798.435408
48	0	3	8400	0	-1388.51923	77.35383205	-0.1816149881	-0.2342347855	9788.51923
49	0	3	8400	0	-1378.673366	77.17350487	-0.1803271727	-0.2331198958	9778.673366
50	0	3	8400	0	-1368.897319	76.99445638	-0.1790484891	-0.23200772	9768.897319
51	0	3	8400	0	-1359.190592	76.81667751	-0.1777788725	-0.2308982762	9759.190592
52	0	3	8400	0	-1349.552695	76.64015925	-0.1765182587	-0.2297915823	9749.552695

At the end of the 52 week treatment our model predicts that we should have went from the baseline weight of 105.8kg to the final weight of 76.64015925kg a weight loss of 29.15984075 kg which is outside of the studies weight loss range of 14.2kg lost with an SD of 10.3 kg by 4.65984075kg(table 3)

4.3 Discussion of the results against available data

Our model was able to stay within the standard deviation(SD) of weight loss for all of the viegener study, the caloric restriction study and standard diet half of the wing 1994 study. It only dipped outside of the SD once for the VLCD in the wing 1994 diet by 4.65984075kg, But for all the studies our model fell into the high ranges of weight lost for the treatments.

4.3.1 Strengths and Weaknesses of the Model

What worked well for our model was that it does not require a lot of initial conditions, which makes it more accessible to the average person. The drawback from this is that there are some factors that could affect a person's weight that aren't considered in our model, particularly body composition and macronutrient consumption. Our model typically stays within the standard deviation of weight loss and works very well with abnormally low calorie intake. Some issues with our model is that it becomes inaccurate when calorie intake varies a lot, for optimal results calorie intake will be constant. Additionally, the MET variable has a bit of wiggle room based on intensity, so there is a bit more discrepancy than would be ideal. Finally, the biggest weakness is that our model tends to predict more weight loss than occurs in reality, especially over long periods of time.

4.3.2 Future Study

Some ideas for future study we came up with was looking at

1. how much of each macronutrient you take can affect your weight loss.
2. How body composition (ie fat tissue, muscle tissue, ect) changes with weight changes
3. Changing our constant 7700 kcal to an equation that will give how much calories are needed to make 1 kg of body mass over time, in hopes to fix the skewing effect we have
4. Changing our Resting Energy Expenditure equation so it accounts for how metabolism can change due to fluctuating caloric intakes

5 Summary

After we looked into how to model Weight Change Based on Net Calories, we decided to make a difference equation that changed our variable weight every time step. The other important parts of our equation was the relationship between calories consumed and calories burned both passively and actively and how a positive difference between calories consumed and burned would result in weight gain and how a negative difference would result in weight loss. Even though the model mathematically can be unstable, the conditions for it to be are way beyond the scope of what this model would be used for so can be ignored.

Our model works fairly well as a predictor of weight loss though it does usually skew to predict more weight loss then what is average but still within possibility and seems to not predict diets that fluctuate in calorie intake well. This is probably due to the model having the conversion rate between kcal to kg be a constant instead of it being its own equation that changes depending on weight or body composition and that the REE(Resting Energy Expenditure) only changes to weight instead of weight and caloric intake so it doesnt model the real world phenomena of diets clowning down your metabolism rate. This is an area of further research that could improve the accuracy of the model over long periods of time. Although the model can still be improved, it is effective in giving a general idea of a person’s body weight over time, which was the goal.

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