

The challenge of keeping it off, a descriptive systematic review of high-quality, follow-up studies of obesity treatments

Abstract: The aim of this systematic review is to answer the question: Is substantial, stable and long-term weight loss a viable goal for adults with obesity? To answer this question, we conducted a broad systematic search of non-surgical and non-pharmacological obesity treatment studies with the following strict criteria 1. Minimum three-year follow-up. 2. Five percent body mass lost. 3. No continued interventions in the follow-up-period. 4. Prospective design. 5. Less than 30% attrition from the start of the follow-up period. While the search revealed a very large number of published articles, only eight studies met the inclusion criteria. Several of the non-included studies report a majority of participants achieving satisfactory weight-loss and little re-gain, especially among studies with continued interventions during the follow-up period. In contrast, the eight high-quality studies included in this study demonstrate a trend of weight-regain towards pre-treatment baseline. This review concludes that the majority of high-quality follow-up treatment studies of obesity are not successful in maintaining weight-loss over time. The results suggest that excess weight can be lost, but is likely regained over time, for the majority of participants.

In 1959, Stunkard et al. conducted the first prospective follow-up study of adult obesity treatment.¹ The majority of the 100 participants were successful in reducing a substantial amount of bodyweight but regained almost all the lost weight over the next two years. However, these poor initial results may not reflect the current treatment of adult obesity, as new treatments have emerged.² Now, 60 years later, there is considerable disagreement regarding the efficacy of obesity treatment.³⁻⁵ Short term weight-loss success is well-documented,^{6,7} but studies with a longer follow-up time show inconsistent results.^{8,9} A large number of journal articles on obesity treatments are published each year and reviewing this voluminous literature is challenging. This is partly because of the size of the body of research, and partly because differences in inclusion criteria can have a notable impact on the conclusions reached. Some reviews do not include follow-up or only very brief follow-up.¹⁰ Others have long follow-up but do not distinguish between substantial and modest weight-loss.¹¹ Some reviews only include studies with substantial weight-loss and long follow-up time but include studies with high rates of attrition.¹² Other reviews include both treatment of childhood and adult obesity¹³ or base conclusions on a mix of drug and behavioral treatments.^{11, 14} In addition, systematic reviews often take the form of meta-analysis between groups of participants in different treatments.¹⁵ Significant differences between groups on different diets, therapy or behavioral treatments contribute to our understanding of obesity treatment. However, between group analyses typically do not emphasize the observed within group weight-regain. Their conclusions are generally positive, and give the impression that weight-loss interventions work, and that weight-loss can be maintained,^{11, 16, 17} often ignoring

the question of long-term stability. Another source of discrepancy is treatment studies with and without a prospective design. Retrospective cross-sectional surveys may have a large sample size but are likely biased towards including participants whom have experienced success. In contrast, representative population data of obese individuals show that the likelihood of achieving a stable and normal weight is very low.¹⁸ Studies with a prospective research design eliminates self-selection, but the validity of their conclusions are dependent on non-systematic attrition rates. Unfortunately, successful individuals and successful trials are more likely to be reported.¹⁹ Individuals who do not achieve sustained weight-loss are arguably more likely to drop out and thus less likely to be included in published literature. High dropout rates in obesity research is a common problem⁶ with some studies have as much as 83% attrition.²⁰ Patients dropping out are less likely to comply with a diet,²¹ rate the intervention program worse,²² and have lower self-efficacy regarding weight-loss.²³ Thus, high rates of attrition can introduce systematic error that may skew the results in a more favorable direction. The publishing process is likely also skewed towards positive conclusions as poor results are less likely to be reported.²⁴ Lastly, conclusions from reviews that include studies with continued interventions during the follow-up period,¹² may be more positive than studies without. Utilizing sustained interventions during the follow-up period is likely to yield more positive results, but this research design limits the generalizability of the treatment to other patients with obesity who do not receive long-term follow-up treatment. This design also begs the question of what happens when all treatment ends. The current study more rigorously examines the evidence for whether or not substantial, stable and long-term weight-loss is viable for obese adults. Reviewing only high-quality follow-up studies of obesity treatment may eliminate some of the inconsistent results seen in obesity research.

Methods

Inclusion criteria

We included studies, written in English/Norwegian/Danish/Swedish, which complied with the following inclusion criteria. We limited the studies to focus on adults only and excluded any studies that include participants below the age of 18. We only included studies of intentional weight-loss that was not due to bariatric surgery, medical or pharmacological interventions. We also excluded studies that use pharmacological options to prevent weight regain.²⁵ In an attempt to identify long term weight changes, we only included prospective studies with a minimum follow-up time of three years. We excluded studies that provided continued interventions during the follow-up period. Studies utilizing continued interventions during the follow-up period are likely more successful than studies without. However, the stability of their long-term results are not sufficiently demonstrated with this research design as results cannot inform on what happens to the patients when the intervention is finished. Because of this, they are excluded from the current study. We included studies where the participants are contacted by phone or other correspondence to register their weight, although this may also serve as a motivational boost. We excluded studies where participants lost less than a mean of 5% of their total body mass. Lastly, we only included studies with an attrition rate during the follow-up period, of less than 30%. We did not limit the studies in regard to attrition rates during the intervention/treatment period.

Search strategy

We identified relevant literature using a broad and inclusive search strategy, shown in figure 1. We searched the databases: MEDLINE, CINAHL, PSYCHINFO & ALLIED for studies published from 1984 to present. We identified journal articles containing multiple semantic variations, and base words, of the three search strings: Obesity/weight-loss, diet/exercise/intervention, and prospective/follow-up. We used exploded search terms in the databases where this is an option. The initial broad search identified 24159 journal articles.

INSERT FIGURE 1 AROUND HERE

Identification

The identification of relevant literature was done in three stages, as shown in figure 2. In the first stage, four research assistants and the study's first author screened titles and abstracts to exclude studies that were in obvious violation of our inclusion criteria. When in doubt, a study was included for further evaluation in phase 2. In phase two we reviewed the articles in full, in accordance with our inclusion criteria.

INSERT FIGURE 2 AROUND HERE

The screening stage removed the majority of our original search results and resulted in 113 articles for more detailed identification, presented in appendix 1. In the screening stage, most of the excluded articles were removed because they were not treatment studies of obesity. During phase one evaluation, we identified if the articles had the necessary follow-up time, used weight-loss drugs, had a prospective design, if participant achieved the necessary amount of body mass lost, as well as no reported intervention during the follow-up period. We identified 95 articles for exclusion. The remaining 18 articles evaluated in phase two are presented in appendix 2. In phase two of the evaluation we calculated attrition rates and further evaluated if any sustained intervention was utilized in the follow-up time. This process excluded an additional 9 articles. The final 8 articles fit our search criteria.

Analysis using simulated data

To graphically present and statistically infer a best fit line for weight regain, we used an approximation of the percentile weight-loss data by simulating individual scores of each study, using normally distributed scores with their respective means and standard deviations

(SD). When studies used adjusted weights (e.g. to adjust for self-report) we used these weights in the analysis. Two of the eight included studies, Schwarzfuchs²⁶ and Pekkarinen,²⁷ did not supply a SD. For these studies, we imputed the mean SD across all studies and time points. For ease of comparison, we used a fixed occasion measurement when coding time at pretreatment and post treatment. Specifically, pretreatment as time zero and post treatment at time ten. We used months following post treatment, plus ten, as our follow-up time measurements. In order to capture the non-linear development seen in each study we employed a linear spline regression, using the `lspline`²⁸ package, with one knot manually placed at posttreatment. The principal advantage with the linear spline is that coefficients capture the slope of change in both the treatment, and the follow-up phase. The two splines are parametrized with slopes of individual segments. The R code for the analyses and simulated data is available at <https://github.com/MagnusNordmo/DietReview>.

Results

Result of the search

The results showed that research efforts are abundant in the field of obesity treatment, but that few high-quality studies are published. The two most common limitations were lack of prospective design and lack of follow-up, as seen in figure 2. Many of the cross-sectional retrospective studies report good results and conclude that a majority of participants have satisfactory weight maintenance outcomes after several years.²⁹⁻³⁵ However, other retrospective evaluations show that the prototypical outcomes are high degrees of weight regain.³⁶⁻⁴¹ The discrepancy in results is likely due to differences in methods. The retrospective studies showing favorable outcomes, are of lower methodological quality either through low response rates, low N, non-substantial weight-loss or systematic bias in the form of self-selection of participants whom achieve success. The studies with short follow-up time

mostly demonstrate favorable outcomes and weight maintenance.⁴²⁻⁵⁰ Prospective studies with close to three years follow-up had notably less favorable outcomes.^{51,52} Among the prospective studies with over three years follow-up, but with high rates of attrition (appendix 2), the majority of the results are quite favorable. Lantz⁵³ concludes that substantial weight-loss can be maintained after a 4-year comprehensive treatment program, with a final mean lost weight of 8.5 percent below pre-treatment baseline. Milsom⁵⁴ concludes that a large portion of participants were able to maintain clinically significant weight-losses, multiple years after treatment. Studies with sustained interventions during the follow-up period also showed very positive results. Using group and individual counseling during the follow-up period, Hakala et al. found a sustained weight-loss effect after five years.⁵⁵ Golay et al. admitted a small number of patients, whom were highly motivated for treatment, to an in-hospital program with a sustained intervention, including re-admission and GP follow-up resulting in mean weight-loss at 7.4% after five years⁵⁶. The favorable outcome achieved by Lantz may also be partly due to sustained interventions during the follow-up.⁵³ These results are informative of what can be expected as a best possible scenario but cannot inform on the weight developments after the intervention ends. The remaining eight studies have low rates of attrition and a follow-up period without sustained interventions. The outcomes of the included studies are presented in figure 3.

INSERT FIGURE 3 AROUND HERE

As seen in table 1, Cooper et al. conducted a high-quality prospective follow-up randomized control trial (RCT) on the treatment of obesity with cognitive-behavioral or behavior therapy with 99 female participants with severe obesity.⁵⁷ The participants were referred by their family physician or respondents to an advertisement placed in hospitals. The

study included a general self-help, control group, which results are left out of the current analysis as they did not achieve substantial weight-loss. Hensrud et al. tracked the weight development of 24 women with moderate obesity after weight-loss without attempts to stagger weight re-gain and can serve as a reference group.⁵⁸ The participants were recruited from a hospital population. Pekkarinnen et al. conducted an RCT and followed 59 men and women with severe obesity five years after a very low energy diet (VLED) and behavior therapy.²⁷ Almost half of the patients dropped out during the treatment phase. After five year, the remaining participants showed favorable results, with a mean sustained weight lost at notable 8.4%. Schwarzfuchs et al. followed 332 participants (86% men) with moderate obesity after a two-year intervention consisting of different diets. The study was an RCT. The sample was recruited from a workplace Participants lost an average of 5% weight. After four years, the participants had a mean weight-loss of 1.9% of initial body weight.²⁶ Stalonas et al. used an exercise and the contingency management component of a behavioral weight control program and followed 36 patients with moderate obesity for five years. The participants were recruited via local advertisement. The average patient gained 6.7% body weight from their pre-treatment weight.⁵⁹

INSERT TABLE 1 AROUND HERE

Vogels et al. treated 91 patients with moderate obesity with a very low-calorie diet and followed them for three years after the intervention.⁶⁰ After three years, the average patient gained 0.8% body mass, compared to pre-treatment baseline. The participants were recruited via local advertisement. Wadden et al (1988). followed 59 patients with severe obesity after a very low-calorie diet and behavior therapy for three years, with an RCT design. Final mean weight-loss was 3.2% below baseline. The participants were recruited via a newspaper

advertisement.⁶¹ Wadden et al (1989). treated 76 women with severe obesity with the same RCT design, consisting of a very low-calorie diet, behaviors therapy or a combination of both. Patients were followed for five years.⁶² The average patient lost 13.5% weight after the treatment. Around half of the participants (55%) reported having received additional weight-reduction therapy during the follow-up period. At the five-year follow-up the mean weight was 2% above pretreatment baseline. These two journal articles both refer to the same treatment study with two cohorts and identical treatment conditions that is reported at different intervals. The latter article combines both cohorts and is included in the current analysis, while the former is removed. Olszanecka-Glinianowicz et al. used a three-month diet and exercise-based weight-loss program to treat 30 women with moderate obesity and measure changes in systemic microinflammation. Participants lost an average of 8.3%. After five years, the participants had returned to baseline weight (0.4% mean weight-loss).⁶³ With the exception of Cooper, the included studies do not show any repeated measures without weight re-gain. As seen in figure 2, most of the weight is regained within the first year. The pattern of re-gain between studies is quite similar, with Pekkarinnen as a positive outlier. The overall best-fit line of all the studies, as a function of linear spline regression is shown in figure 3.

INSERT FIGURE 3 AROUND HERE

As seen in figure 3 mean weight lost was 91.4%, across all studies after the treatment phase. The average rate of weight regain in the follow-up phase was 0.14 % body weight each month, reaching pre-intervention weight at roughly 4.1 years post intervention, as shown in table 1. If Pekkarinnen et al. is removed from the analysis, the rate of regain per month is 0.15 %, reaching pre-treatment baseline after approximately 4 years.

INSERT TABLE 2 AROUND HERE

Discussion

All studies show significant weight regain and trends to pretreatment baseline weight. The notable exception is Pekkarinnen et al.²⁷ However, as a measure of the stability of the average weight-loss experience it has notable features which may explain why it outperforms the other studies reviewed. The attrition rate from the follow-up time is within the inclusion criteria, but the attrition rate in the treatment phase is very high, with only half of the original sample measured at follow-up, most dropping off during the treatment phase. Also, over half of the participants reported receiving other non-surgical weight treatments during the follow-up period. This might skew the results in a favorable direction that could give a misleading representation of weight regain probability. It also has a low amount of follow-up participants. Given the study's notable departure from the overall trend, its limited and low sample size and treatment attrition, it seems likely that it is not as good of a representation of post intervention weight-regain, as the other studies included in this review. These show some variation, but all conclude that most participants fail to achieve sustained weight-loss. Only Cooper et al. found a pattern of weight stabilization just below the pretreatment weight. The other studies show increasing weight at every measurement point. The results from studies with no effort to stagger weight-regain⁵⁸ and studies with the explicit intent to treat cognitive behavioral mechanisms that contribute to regain⁵⁷ are remarkably similar. Differences in the amount of weight lost during treatment emerged between the studies. These differences in weight lost correspond to differences in pre-treatment weight, but do not appear to be related to probability of weight re-gain. However, due to limited evidence we cannot conclude that

there is no association between the amount of weight lost and the probability of weight re-gain.

The aim of this study was to determine if high-quality studies of obesity treatment support the notion of achieving substantial, stable and sustainable weight-loss, for the average person engaged in weight-loss treatments. The studies included in this review indicates that this notion is not supported by research evidence. The results indicate that substantial weight-loss is possible, but not stable or sustainable for the majority of dieters without a continued follow-up intervention. The results of the search reveals that there are very few robust studies, a sentiment echoed in other reviews.¹⁶ This is because of two possibilities: Either the research is not being done or it is not being published. The efficacy and sustainability of weight-loss interventions would arguably be better understood with more registered reports, reducing the likelihood of negative results being omitted from the literature.²⁴ Many of the non-included studies with lower methodological quality do show that substantial weight-loss is possible. The results are interesting as success stories but do little to inform the probability of success in maintaining weight-loss for the individual person with obesity.

Limitations

The current study has some limitations. Firstly, due to the sheer amount of available studies to screen, we cannot definitively rule out that some studies were wrongly excluded during the screening. On the other hand, the large number of journal articles identified with the current search strategy reduced the chances of not discovering relevant research. However, only reading titles and abstracts increases the likelihood of wrongly excluding articles, that would have been included if the entire article was read. Secondly, simulating data based on means and standard deviations makes it impossible to do analysis of individuals weight trajectory. The data, figures and best fit lines presented here should only be interpreted at the group-level. The search strategy used to discover relevant articles also has limitations.

The results of the search may have uncovered more relevant articles with more relevant keywords, such as “*treatment*”. The screening process also has the limitation of not systematically organizing the excluded studies. If a title or abstract read: “*follow-up of one year*” it would likely have been excluded in the screening process. Because of this, the articles in the evaluation phases (appendix 1 & 2) are not representative of the field of obesity treatment. Lastly, the results of this review cannot be generalized to the treatment of childhood obesity, treatment with sustained interventions or bariatric and pharmacological treatments of obesity.

General discussion

A number of psychological and somatic changes designed to revert the weight-loss have been documented. These include a reduced resting metabolism,⁶⁴ increased satiety for high fat, high sugar foods,⁶⁵ dysfunction release of hunger and fullness hormones⁶⁶ as well as a decrease in satiety regulating Leptin.⁶⁷ Because of these mechanisms, body weight is under strong physiological control and there is considerable effort required to avoid re-gain. If the individual continues the restrictive diet and exercise regimes that accompanied the period of weight-loss, maintenance is possible. However, the focus on diet and exercise might be difficult to maintain post intervention. Secondly, even with complete commitment, life-events, physical or psychological problems may disrupt the maintenance project, causing weight re-gain⁶⁸ The low probability of success reviewed here may be a part of the explanation of why, for some individuals, dieting is more likely to increase, not decrease weight in the long term,⁶⁹ even when controlling for genetic factors.⁷⁰ The current study highlights the relevance of prevention, rather than treatment interventions, as well as alternative approaches such as a health at every size approach.⁷¹ In addition, it suggest that stopping weight gain and establishing health promoting eating habits may be a more viable

goal in treating adult individuals with obesity and that weight management is a lifelong process, not a short term goal.

Conclusion

The field of obesity treatments has some notable inconsistencies. Some studies are optimistic about the prospect of sustained weight-loss,^{4,9, 11,16,17} while others are not^{1, 18}. The negative results of the eight high-quality follow-up studies reviewed here suggest that weight-loss without continued treatment results in weight regain for most people. These results are in contrast to studies with sustained interventions, which are more likely to support sustained weight-loss.^{53, 55, 56} The negative results reviewed here are also a departure from the positive conclusions of studies with retrospective design and high rates of attrition.²⁹⁻³⁵

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Table 1. Characteristics of the included studies

Author	Year	Treatment	Sample recruitment	Follow-up length	Final weight change	N
Cooper	2010	CBT/BT*	Hospital	3 years	-1.4%	99
Hensrud	1994	Provided meals	Hospital	4 years	-1.8%	24
Olszanecka-Glinianowicz	2012	Diet and exercise	Unknown	5 years	-0.4%	30
Pekkarinnen	1997	VLED/BT	Hospital	5 years	-8.4%	35
Schwarzfuchs	2012	Diet	Workplace	4 years	-1.9%	332
Stalonas	1984	Diet and exercise	Advertisement	5 years	+6.7%	36
Vogels	2005	VLED	Advertisement	3 years	+0.8%	91
Wadden	1989	VLCD/BT	Unknown	5 years	+2.0%	76

* BT: Behavior therapy

Table 2. Linear Spline Regression

Coefficients	Estimate	95 % CI	Std.Error	T value	P value
Intercept	100	99.2 – 100.8	0.43	232.8	> 0.000 ***
Treatment phase	-0.73	-0.84 – 0.63	0.05	-13.5	> 0.000 ***
Follow-up phase	0.14	0.12 – 0.16	0.01	12.6	> 0.000 ***

*** p < .001, Multiple R²: 0.06, F-statistic (2,3195): 99.3

Figure 1. Three-pronged search strategy with keywords

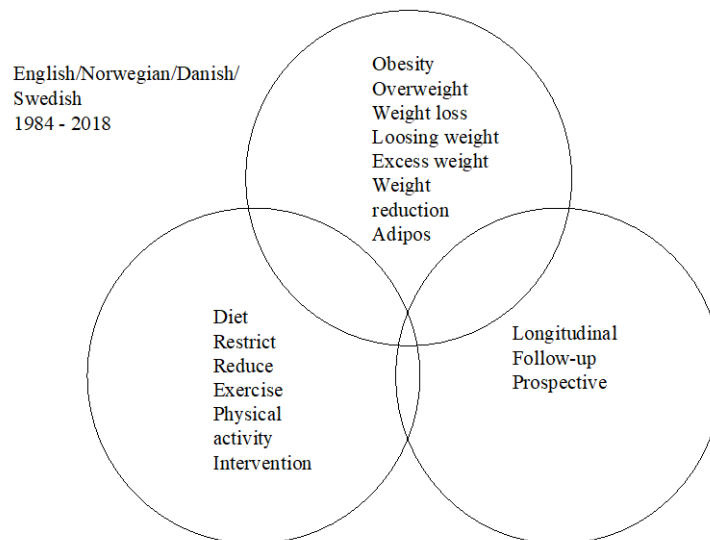


Figure 2. Flow diagram of systematic literature search, screening and identification.

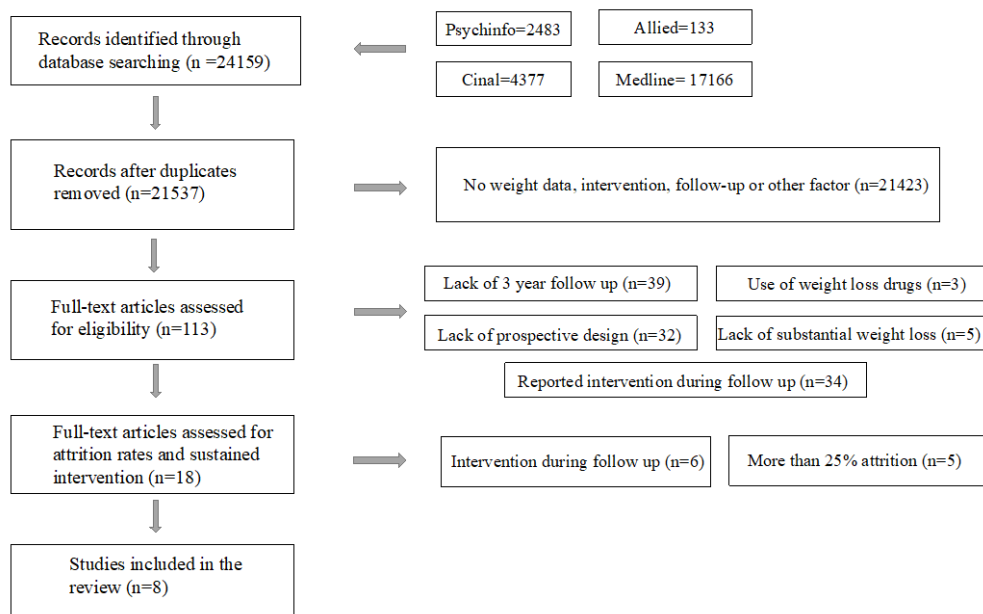


Figure 3. Percent weight changes over time. Treatment length varied from study to study, not illustrated here.

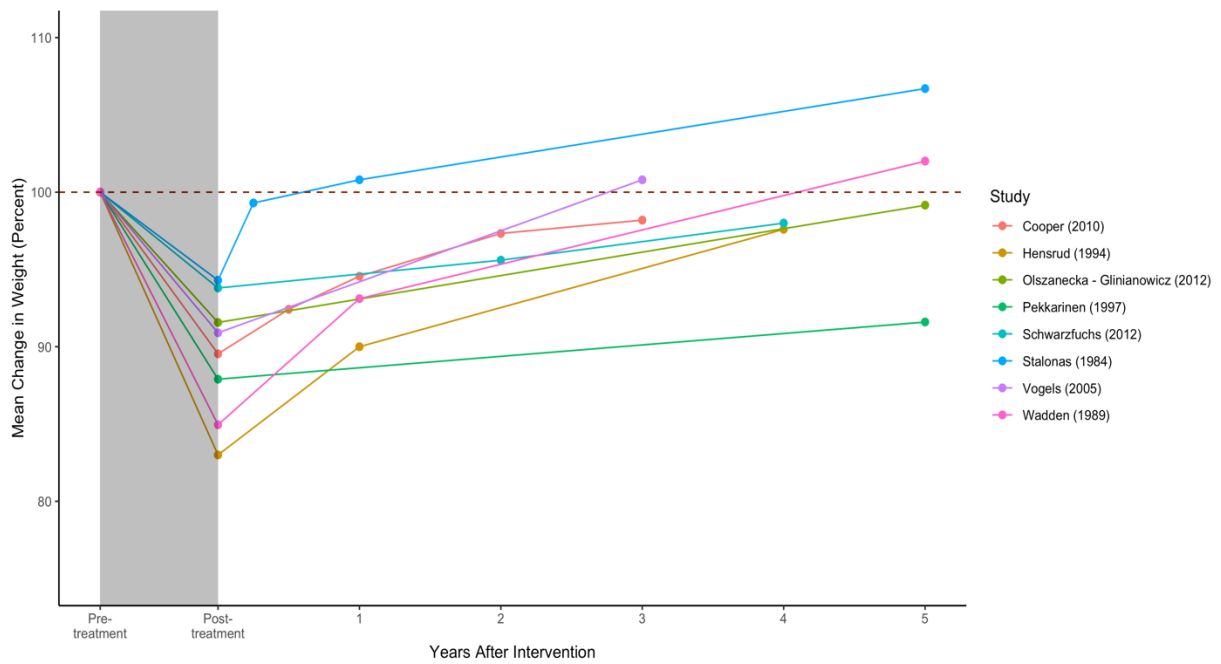


Figure 4: The percent of mean weight change across all studies over time with simulated data points, using spline regression.

