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Systematic Review

Psychosocial Pretreatment Predictors of Weight Control: A Systematic Review Update

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Correlates · Moderators · Obesity · Weight management · Success

Abstract
Objective: Systematically identifying pretreatment characteristics that predict successful weight management is important to improve intervention efficacy and clinical practice. This study provides a comprehensive update of a 2005 review on pretreatment predictors of successful weight management. ***Methods:*** Results of 37 recent original studies from peer-reviewed journals were merged with the results from the 2005 review. A critical appraisal of the 66 studies included was provided, and meta-analyses were performed when feasible. ***Results:*** Fewer previous weight loss attempts were the most consistent pretreatment predictor of successful weight management, although with a small effect size. Importantly, several variables were identified as non-significant predictors of weight loss, showing trivial effects (e.g., eating self-efficacy). Many psychosocial factors remain too little studied to allow reliable conclusions regarding their predictive value. ***Conclusion:*** Previous dieting attempts were identified as the soundest predictor of successful weight management. Several factors, previously considered barriers to successful weight management and now identified as non-predictors, require more investigation given the limitations identified in this review. Importantly, due to a comparably thin empirical basis for many predictors, further research is essential to move the field forward. Implications of the current state of research and necessary steps to improve intervention efficacy and clinical practice are discussed

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Obes Facts 2018;11:67–82
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Introduction

Obesity is the consequence of a sustained, chronic, positive energy balance, with physiological and behavioral factors influencing the regulation of both energy intake and energy expenditure [1]. Lifestyle interventions for weight loss have been shown to produce significant weight reductions and improved health in overweight and obese individuals [2, 3]. However, even in very effective weight loss programs, many individuals fail to achieve meaningful weight loss, and some even gain weight. Many researchers have sought to identify relevant pretreatment characteristics to better predict which participants will more likely be successful in their upcoming weight management process. However, reliably predicting weight outcomes is difficult, with most studies only accounting for 20–30% of the total variance in weight loss outcomes [4].

Identifying participant characteristics that predict weight loss and weight loss maintenance could contribute to improve intervention efficacy and clinical practice by helping health care professionals direct their efforts to the enhancement of participants' relevant, change-worthy, psychological, and behavioral aspects. Additionally, identifying individual characteristics associated with unsuccessful weight loss outcomes might facilitate predicting who is most and least likely to succeed within evidence-based lifestyle weight control interventions, guide resource allocation, and find those who are in need for alternative interventions.

In a previous comprehensive review of the literature on pretreatment predictors of weight control conducted in 2005, Teixeira and colleagues [5] concluded that research efforts had resulted in predictive models with limited usefulness for clinical practice. Consequently, at that time, no definitive conclusions could be drawn regarding matching individuals – based on psychosocial and behavioral characteristics – to specific treatments. Similarly, there was insufficient data to make recommendations concerning participants for whom behavioral weight loss treatment was most likely unsuccessful. Since that review, many more studies have been published, treatment programs have evolved, and new variables have been tested as potential predictors of weight loss. Taking these aspects into consideration, as well as the potential utility of prospectively forecasting outcomes in obesity treatment, we believe that an update on pretreatment predictors of weight loss is justified. Therefore, this systematic review aims to summarize and provide a critical appraisal of the current status of research on pretreatment predictors of weight control in lifestyle obesity interventions.

Material and Methods

This systematic review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) statement [6].

Eligibility Criteria

Articles published since 2005 reporting associations between pretreatment individual characteristics and subsequent weight loss in the context of lifestyle obesity interventions were retrieved. The articles were then analyzed cumulatively with the scientific evidence identified in the previous review [7]. To make the results of this review comparable to the 2005 review, the current review used the same inclusion criteria: i) study participants were adults (≥ 18 years old). ii) Only studies with experimental designs (i.e., randomized controlled trials, comparative trials, single-arm intervention trials, or pilot studies using an experimental design) were included. iii) Only studies encompassing clinical or community 'lifestyle/behavioral interventions' defined as interventions that promote change in energy balance-related behaviors (such as diet and physical activity) and psychological factors (such as body image, motivation, or self-monitoring) relevant for weight management were included. iv) Studies using meal replacements, hypocaloric balanced diets (HBD; approximately 1,200–1,500 kcal/day), low-calorie diets (LCD; approximately 800–1,200 kcal/day), very-low

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calorie diets (VLCD; <800 kcal/day), and treatment for binge eating disorder (BED) were included as long as weight loss was a clear outcome and a behavioral intervention was present. v) Weight loss was a primary or secondary outcome. vi) Putative predictors were predominantly self-reported psychosocial measures. As in the previous review, studies analyzing demographic variables other than initial weight or BMI were excluded. Studies including populations diagnosed with major illnesses (e.g., psychotic disorders); studies using surgical procedures, pharmacotherapy for weight loss without a behavioral component, including interventions to prevent weight gain; non-intervention studies, case reports, and qualitative studies; and studies not published in peer-reviewed journals were excluded. The current review update is registered on PROSPERO (registration number CRD42015017110).

Search Strategy

A comprehensive search of peer-reviewed articles published between January 2005 and January 2017 (including online ahead of print publications) was conducted in the following electronic databases: Pubmed, PsycINFO, Embase, and CINAHL. Searches included all meaningful combinations of four sets of terms: i) terms concerning the health condition or population of interest (e.g., adults > 18 years old); ii) terms concerning the intervention(s) /exposure(s) evaluated (e.g., behavioral or lifestyle interventions); iii) terms representing the outcomes of interest (i.e., weight loss, weight change); and iv) terms concerning pretreatment predictors of interest (i.e. psychological, self-regulation), including all predictors identified in the previous review (see supplemental table 1 (available at *http://content.karger.com/ProdukteDB/produkte.asp?doi=485838*) for a full search example; a complete list of search strategies can be obtained from the authors). Other sources included manual cross-referencing of literature cited in prior reviews, and hand-searches of the content of key scientific journals (i.e., *Obesity Reviews; International Journal of Obesity; Obesity; Obesity Facts; International Journal of Behavioral Nutrition and Physical Activity; Journal of the American Dietetic Association*).

Screening and Extraction

All abstracts identified from the literature searches were screened for potential inclusion eligibility by two authors (EVC, IS). A data extraction form was developed to include information about the article (e.g., authors, year), participants (e.g., demographics, BMI), study design, intervention characteristics (e.g., aim/type, length, follow-up), pretreatment predictors (and their measurement instruments), and outcomes of interest. For a complete list of predictors identified in this review see table 1. Data extraction was conducted by the first author (EVC), and uncertainties were solved through discussions with the second author (IS).

Quality Assessment

Study quality was assessed with the Quality Assessment Tool for Quantitative Studies [8], evaluating six key methodological domains: study design, blinding, representativeness (selection bias), representativeness (withdrawals/dropouts), confounders, and data collection. Each domain was classified in *strong*, *moderate,* and *weak* methodological quality. A global rating was determined based on the scores of each component. Two authors independently rated the six domains and overall quality (EVC, IS). Discrepancies were discussed until a consensus was reached. Inter-rater agreement across categories was good: selection bias (Cohen's $\kappa = 0.79$), study design ($\kappa = 0.81$), confounders ($\kappa = 0.73$), blinding ($\kappa = 1.00$), data collection ($\kappa = 0.81$), and withdrawals/dropouts ($\kappa = 0.69$).

Data Synthesis

This review analyzed pretreatment psychosocial predictors of weight control in lifestyle obesity interventions. Changes in weight are reported in supplemental table 2 (available at *http://content.karger.com/ProdukteDB/produkte.asp?doi=485838*). For a full list of variables tested as pretreatment predictors of weight loss/maintenance see table 1. Results are shown separately for each predictor, specifically i) number of studies, ii) number of times it was tested (a study could present data for multiple assessment points), iii) time of assessment – post-intervention weight loss (WL); post-intervention + follow-up (WLM, weight loss maintenance); and follow-up (WM, weight maintenance) –, and iv) the number of times each association effect was found, namely 'no association', 'positive association', or 'negative association' (table 1). Only unadjusted correlations were considered. The identified predictors are labeled as reported in the studies. Categorizations of predictors were avoided to facilitate the interpretation of the constructs as they were initially measured. The instruments used to assess predictors in each study are included in supplemental table 2 (available at *http://content.karger.com/ProdukteDB/produkte.asp?doi=485838*).

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Table 1. Association between all the identified pretreatment predictors/correlates of success and subsequent weight loss and/or maintenance

Predictors	Number of studies	Times tested	No association				Significant association							
							positive				negative			
			all	WL	WLM	WM	all	WL	WLM	WM	all	WL	WLM	WM
Initial weight/BMI (higher)	24	27	10^{5}	3^{1}	4^{3}	3^{1}	11^{6}	9^{5}	2^{1}		6^{3}	4^{1}		2^{2}
Binge eating	11	13	10^{3}	4	4^{2}	2^{1}	2^{1}	2^{1}			1		1	
Cognitive eating restraint	11	13	11^{3}	5^{1}	3^{1}	3^{1}	1		1		1	1		
Eating disinhibition	10	11	9^{3}	4^{1}	2^{1}	3^{1}	1^{1}			1^{1}	1		1	
Eating self-efficacy	10	11	8^{1}	5^{1}	3		3^{1}	3^{1}			0			
Depression symptoms	9	9	8^{4}	4^{3}	3^{1}	1	1	1			0			
Fewer previous weight loss attempts	8	9	3^{1}	3^{1}			6^{1}	3	2	1^{1}	0			
Perceived hunger	8	9	8^{2}	4^{1}	2^{1}	2	0				1^{1}			1^{1}
Higher weight loss goals/expectations	7	9	5^{2}	2^{1}	2^{1}	1	3^{1}	2^{1}	1		1	1		
Self-esteem	6	6	5^{1}	3	1	1^{1}	1	1			0			
Exercise self-efficacy	5	6	5	4	1		1		1		0			
Body shape concerns /overvaluation	5	5	4^{1}	2^{1}	2		0				1^{1}			1^{1}
Exercise social support	4	4	3	1	2		1^{1}	1^{1}			0			
Quality of life (general, health-related)	4	4	3^{1}	2^{1}	1		1	1			0			
Autonomous motivation	3	4	2	1	1		2^{2}	1^{1}	1^{1}		0			
Controlled motivation	3	4	2^{1}		2^{1}		0				2^{1}	2^{1}		
Internal locus of control	3	4	2^{2}	1^{1}	1^{1}		2^{1}	1		1^{1}	0			
Emotional eating	3	3	2	1	1		1	1			0			
Healthy eating social support	3	3	2^{1}	1^{1}	1		0				1^{1}	1^{1}		
Perceived social support (general)	3	3	3^{1}	2^{1}	1		0				0			
General self-efficacy	3	3	1		1		2	2			0			
Weight control self-efficacy	3	3	1	1			2^{2}	2^{2}			0			
Perceived autonomy support	2	3	2^{1}		2^{1}		1^{1}	1^{1}			0			
Body dissatisfaction	2	2	2	1	1		0				0			
Bulimic behavior	2	2	1^{1}		1^{1}		1^{1}	1^{1}			0			
Craving	2	2	2	1	1		0				0			
Dispositional optimism	2	2	2^{1}	2^{1}			0				0			

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Obesity Facts
The European Journal of Obesity
Obes Facts 2018;11:67–82
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Table 1. Continued

Predictors	Number of studies	Times tested	No association				Significant association							
							positive				negative			
			all	WL	WLM	WM	all	WL	WLM	WM	all	WL	WLM	WM
Exercise perceived barriers	2	2	1	1			0				1		1	
Negative affect	2	2	1	1			0				1		1	
Perceived controllability of obesity problem	2	2	1[1]	1[1]			1[1]	1[1]			0			
Perceived stability of obesity problem	2	2	2[2]	2[2]			0				0			
Perceived consequences of obesity problem	2	2	2[2]	2[2]			0				0			
Quality of life (obesity-specific)	2	2	2	1	1		0				0			
Readiness for weight loss	2	2	1	1			0				0			
Conscientiousness	1	2	2	1		1	0				0			
Extraversion	1	2	2	1		1	0				0			
Feeling deprived while eating	1	2	2	1	1		0				0			
Neuroticism	1	2	1	1			1			1	0			
Perceived stress	1	2	2	1	1		0				0			
Regulatory promotion focus	1	2	2	1	1		0				0			
Regulatory prevention focus	1	2	2	1	1		0				0			
Self-control	1	2	2	1		1	0				0			
Autonomy orientation	1	1	1[1]	1[1]			0				0			
Catastrophising	1	1	1	1			0				0			
Cognitive performance	1	1	1	1			0				0			
Cognitive style regarding diet lapses	1	1	0				0				1	1		
Detachment	1	1	1[1]		1[1]		0				0			
Dispositional pessimism	1	1	1	1			0				0			
Drive for thinness	1	1	1[1]	1[1]			0				0			
External eating	1	1	1	1			0				0			
Guilt	1	1	1[1]		1[1]		0				0			
Imperatives	1	1	1	1			0				0			
Impression management	1	1	0				1	1			0			
Impulsivity	1	1	1[1]		1[1]		0				0			
Indirect aggression	1	1	1[1]		1[1]		0				0			
Ineffectiveness	1	1	1[1]	1[1]			0				0			

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Obesity Facts
The European Journal of Obesity
Obes Facts 2018;11:67–82
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Table 1. Continued

Predictors	Number of studies	Times tested	No association				Significant association							
							positive				negative			
			all	WL	WLM	WM	all	WL	WLM	WM	all	WL	WLM	WM
Inhibition of aggression	1	1	1[1]		1[1]		0				0			
Interpersonal distrust	1	1	0				0				1[1]	1[1]		
Irritability	1	1	1[1]		1[1]		0				0			
Maturity fears	1	1	1[1]	1[1]			0				0			
Monotony avoidance	1	1	1[1]		1[1]		0				0			
Muscular tension	1	1	1[1]		1[1]		0				0			
Need for approval	1	1	1	1			0				0			
Need to success	1	1	1	1			0				0			
Perfectionism	1	1	1[1]	1[1]			0				0			
Pleasing others	1	1	1	1			0				0			
Psychasthenia	1	1	1[1]		1[1]		0				0			
Psychic anxiety	1	1	1[1]		1[1]		0				0			
Socialization	1	1	1[1]		1[1]		0				0			
Somatic anxiety	1	1	1[1]		1[1]		0				0			
Suspicion	1	1	1[1]		1[1]		0				0			
Verbal aggression	1	1	1[1]		1[1]		0				0			
Vulnerability	1	1	0				1	1			0			
Perceived sabotage	0	0	0				0				0			
Perceived strain (general)	0	0	0				0				0			

Number of studies = Number of studies that tested the predictor; Times tested = number of times each predictor was tested (some within the same study); All = studies reporting that effect were all included, independent of the outcome assessment point; WL = only studies reporting weight change from baseline to intervention's end considered; WLM = only studies reporting weight change from baseline to the end of follow-up considered; WM = only studies reporting weight change from intervention's end to the end of follow-up considered.

Superscript numbers represent the number of weak quality studies within each category, in total and discriminated by outcome assessment point; predictors are organized in descendent order by number of studies available.

Obes Facts 2018;11:67–82
DOI: 10.1159/000485838

Data Extraction

Effect sizes (ES) r were computed based on the extracted sample sizes and simple unadjusted correlation coefficients as reported in the studies, or provided by the corresponding authors who were contacted when this data was missing. When the information requested was not provided, the following alternative information was extracted to calculate the effect sizes: i) Mean, SD, and sample size N; ii) t-test, sample size N; iii) X^2, sample size N; and iv) standardized mean difference d. Only data from completers-only analyses was used in this review. When studies included different comparison arms (i.e., comparative or controlled trials), most of them presented weight loss prediction results for the whole sample, not discriminating between the groups/arms. In face of this and considering that our main goal was the identification of pretreatment predictors of success in weight loss/maintenance, independent of the type of intervention received, we used data from all groups combined. When several measures were reported for the same predictor (e.g., cognitive eating restraint), we chose the measure most commonly used across the studies included, as done in previous systematic reviews and meta-analyses [9].

Data Analysis

Analyses were conducted using the Comprehensive Meta-Analysis (CMA) Software version 3.3.070 [10]. Separate meta-analyses were conducted for each identified pretreatment predictor and for each outcome assessment point (WL, WLM, and WM), for which there was sufficient data. Meta-analyses were conducted only when there were 4 or more studies (per predictor and assessment point), to allow interpretability of the data. This option was made given the high variability across studies in interventions' length and type, follow-up's length (when relevant for the analysis), sample size, measurement instruments, and the presence of different outcome formats.

The outcome variable was continuous, but the format in which it was reported in the studies varied: In 39 studies, weight change was expressed in absolute terms (in kg); 13 studies used percent weight loss as outcome, and 13 dichotomized the outcome (success/failure). Two studies did not specify the outcome unit and were excluded from the meta-analyses. Using conversions between different outcome measures and subsequently combining effect sizes is preferable to omitting the studies that used an alternate metric, which would involve loss of information and a biased sample of studies [11]. Still, as a safety measure and following previous recommendations [11], sensitivity analysis comparing results with and without the converted metrics were conducted for each predictor, for which there was sufficient data.

When studies including different comparison arms provided data separately for each arm, composite effect sizes were computed in CMA using study as the unit of analysis [11].

Meta-analyses were conducted with fixed-effects models, because most analyses were based on a limited number of studies (<6), which increases the error when estimating the combined effect in random-effects models [11]. The only exceptions were the analyses for initial BMI (N = 13) and eating self-efficacy (N = 8) at intervention's end, in which the recommended random-effects model was used due to the higher number of available studies [11]. Effect sizes were computed based on sample size and simple unadjusted correlation coefficients r between each predictor and weight change, as reported in the studies, requested from the authors of the paper (which were contacted when these coefficients were unavailable in their publications), or converted based on the alternative parameters (e.g., t-values, N, Mean, SD, chi-square values). Effect sizes were interpreted according to Cohen's guidelines [12], with values of 0.10, 0.30 and 0.50 for small, medium and large effect sizes, respectively. The 95% CI, Z values and corresponding p values were considered as indicators of statistical significance. We also inspected the standard residuals (i.e., how much each study differed from the overall effect) for outliers (>1.96).

Heterogeneity was tested using the I^2 statistic [13] and the Cochran's Q statistic [14]. The I^2 statistic measures the proportion of observed dispersion that is due to real differences in the actual effect sizes and is not affected by low statistical power. The I^2 ranges from 0 to 100%, where a value of 0% indicates no observed heterogeneity and values of 25%, 50% or 75% reflect low, moderate or high heterogeneity [13]. The Cochran's Q statistic demonstrates that studies do not share a common effect size (i.e., there is heterogeneity in the effect sizes between studies) when a significant p value (<0.05) is found [14].

Sensitivity Analysis

Sensitivity analyses were carried out to explore the impact of risk of bias on effect sizes, by repeating primary analyses with the exclusion of studies with i) weak quality studies and ii) detected outliers (>1.96). Given that different outcome formats were considered, some of which required metric conversion and the estimation of effect sizes (i.e., categorical outcomes), analyses were repeated without the estimated values.

Obes Facts 2018;11:67–82
DOI: 10.1159/000485838

When sufficient data remained, analyses were also repeated separately i) for studies reporting absolute weight changes (in kg), and ii) for studies reporting percent weight changes. The potential for publication bias was subjectively assessed by inspecting funnel plots for asymmetry. They were quantitatively assessed using Egger's test [15] and Duval and Tweedie's trim-and-fill method [16], only when 10 or more studies were available per predictor and no substantial heterogeneity was present, because the power is too low to distinguish chance from real asymmetry [17].

Results

Study Selection

Pubmed searches generated 946 publications, PsychInfo 220 publications, EMBASE 339 publications, and CINAHL 109 publications. We manually added 23 publications from previous reviews and reference lists of retrieved papers. Of 1,109 abstracts (after 528 duplicates were removed), 68 were considered potentially relevant, and full-text articles were retrieved. 37 papers met all inclusion criteria and were included in the present review update (fig. 1). These papers were merged with the 29 already included in the original review, resulting in a total of 66 studies.

Study Characteristics

Half of the studies were non-controlled trials (n = 33), mainly aiming at weight loss or weight loss maintenance. Most interventions took place in research centers (n = 32) or clinical/health care centers (n = 23), and approximately half lasted less than 6 months (n = 28). Of these, only 13 studies included a follow-up/maintenance phase, which lasted on average approximately 84 weeks. 19 studies included female subjects only, while 47 had mixed-gender samples. Initial mean BMI for participants varied from ~28 to ~46 kg/m^2, and sample size ranged from 30 to 9,037 participants. The average duration of the weight loss phase was 26 weeks (ranging from 4 to 96 weeks). The average amount of weight lost was 8–9 kg. Of the 13 studies that included a follow-up/maintenance phase, only 6 reported weight changes between the end of the weight loss intervention and the end of the follow-up period.

The most typical outcome variable was weight loss, expressed either in absolute (kg) or relative (% of initial weight) terms. In 13 cases, the dependent measure was a categorical variable, based on specific weight loss/maintenance criteria (e.g., reaching 5% weight loss). Weight changes are reported for subjects completing the study. Considering the high variability of attrition rates (range– to 52%) and that attrition rates were not reported in 20 studies, intention-to-treat analyses would likely have yielded lower average weight loss. For descriptive characteristics of all studies included in this review and respective bibliographic information see supplemental table 2 (available at *http://content.karger.com/ProdukteDB/produkte.asp?doi=485838*).

Quality Assessment

Of the 66 studies identified as relevant for this review, the methodological quality of three studies was rated as 'strong', 40 were classified as 'moderate', and 23 were rated as 'weak'. Although all studies included were intervention studies, half of them were non-randomized trials and therefore rated as moderate for study design. All randomized studies, except for one, which was classified as strong, were rated as moderate regarding blinding of participants (during recruitment) and outcome assessors; the remaining 33 studies were non-randomized and thus not rated on blinding. Five studies were rated as moderate regarding selection bias (representativeness); the remaining 61 studies were rated as weak,

Obes Facts 2018;11:67–82
DOI: 10.1159/000485838

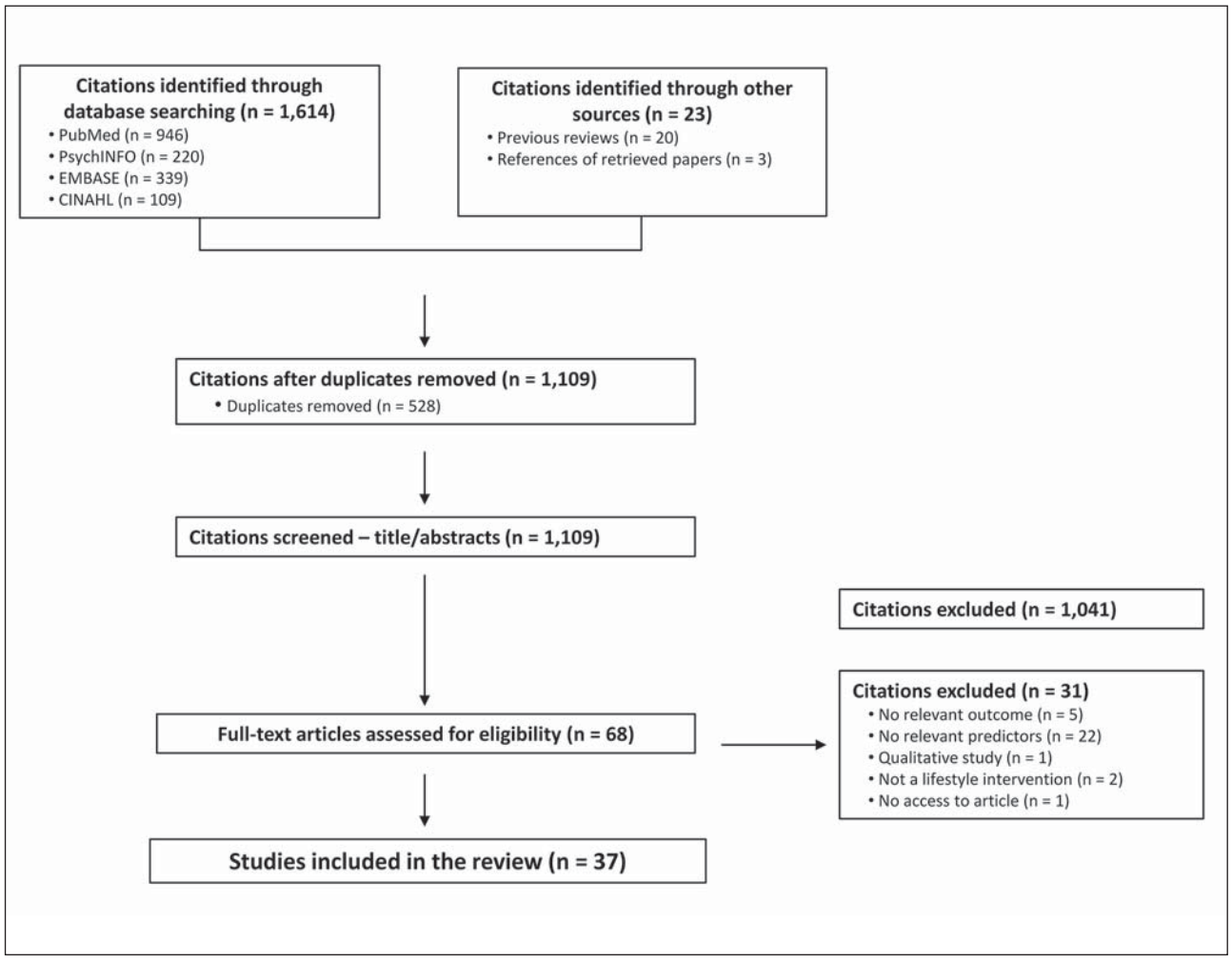

Fig. 1. Flow diagram of studies.

mostly because the sample was self-selected or composed of volunteers. Regarding reporting of withdrawals and dropouts, most studies were rated as strong (N = 28). 12 were rated as weak because they reported retention rates below 60% or did not report this data. With regard to adjusting analyses for confounders, 34 studies were classified as strong, 15 as moderate, and 17 as weak; most of the latter did not include information about confounders or made very few adjustments. In terms of data collection tools, 35 studies were rated as strong, 21 as moderate, and 10 studies as weak for not providing information about validity or reliability of their measures. For a detailed classification of each domain and study see supplemental table 3 (available at *http://content.karger.com/ProdukteDB/produkte.asp?doi=485838*).

Predictors/Correlates of Successful Weight Control

Table 1 shows a data analytic synthesis of the 76 pretreatment predictors of weight loss and/or maintenance tested in the studies included in the overall review (N = 66 studies). Table 2 shows the meta-analytic results for the 8 predictors that provided sufficient data to estimate effect sizes. The respective forest plots are presented in supplemental figures 1 and 2 (available at *http://content.karger.com/ProdukteDB/produkte.asp?doi=485838*).

Obesity Facts
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Table 2. Meta-analyses results of predictors of weight loss and/or maintenance

Predictors	Outcome assessment point	Number of studies	Number of studies by quality	Sample size	Range of intervention length	Range of follow-up length	Effect size r (95% CI)	*Z*	Q	I^2
Initial BMI	WL	13	1 strong 7 moderate 5 weak	15,572	8–52 weeks	–	0.13 (0.02–0.24) [1]	2.37*	407.05***	97%
Initial BMI	WM	4	2 moderate 2 weak	368	8–48 weeks	60–144 weeks	–0.02 (–0.12, 0.09)	-0.30	16.90**	82%
Eating self-efficacy	WL	8	1 strong 6 moderate 1 weak	1,869	4–48 weeks	–	0.06 (–0.02, 0.14) [1]	1.37	18.61*	62%
Binge eating	WL	5	5 moderate	864	4–24 weeks	–	0.06 (–0.01, 0.13)	1.82	8.76	54%
Previous weight loss attempts	WL	5	1 strong 4 moderate	1,240	6–48 weeks	–	0.10 (0.05, 0.15)	4.01***	11.79*	66%
Weight loss goals/expectations	WL	4	3 moderate 1 weak	2,140	8–48 weeks	–	–0.07 (–0.11, –0.02)	-3.13**	144.40***	98%
Cognitive eating restraint	WL	4	4 moderate	835	16–48 weeks	–	–0.05 (–0.12, 0.02)	-1.42	3.17	5%
Exercise self-efficacy	WL	4	1 strong 3 moderate	774	16–48 weeks	–	0.05 (–0.02, 0.12)	1.34	1.90	0%
Eating disinhibition	WM	4	2 moderate 2 weak	321	8–48 weeks	60–144 weeks	–0.03 (–0.13, 0.07)	-0.61	11.55*	74%

WL = Only studies reporting weight change from baseline to intervention's end considered; WLM = only studies reporting weight change from baseline to the end of follow-up considered; WM = only studies reporting weight change from intervention's end to the end of follow-up considered.

1Random-effect models were used to compute these effect sizes; all remaining effects were estimated with fixed-effect models.

*p < 0.05; ** p < 0.01; *** p < 0.001.

Initial BMI was the most frequently studied predictor of subsequent weight loss (N = 24), with approximately 40% of the studies reporting no significant association with weight loss and/or maintenance and another 40% reporting a positive association. Data on the associations between initial BMI and weight change was available for 13 studies at post-treatment (ranging from 8 to 52 weeks after baseline) and for 4 studies at the end of follow-up (ranging from 60 to 144 weeks after the end of the intervention period). A small but significant effect size was found for initial BMI at intervention's end (r = 0.13; 95% CI 0.02–0.24), but not at the end of follow-up (r = –0.02; 95% CI –0.12 to 0.09). At both assessment points, the effects varied widely from study to study. At intervention's end, the study conducted by Benyamini et al. [18] showed the largest effect size but in the opposite direction (r = –0.33); the standard residual suggested this effect size was an outlier. If this study was removed, the overall effect size would increase by 0.04, suggesting this study had no impact on the overall effect size. High heterogeneity between studies was found (Q = 407.05, $p < 0.001$; $I^2 = 97\%$). Concerning the prediction of weight change at the end of follow-up, standard residuals suggested high heterogeneity between studies, further confirmed by heterogeneity statistics (Q = 16.90, $p < 0.01$; $I^2 = 82\%$). Thus, these results should be interpreted with caution.

Fewer previous weight loss attempts were tested as a predictor of subsequent weight loss and/or maintenance in 8 studies, with a shorter history of previous diet attempts being identified as protective against unsuccessful weight loss in 67% of the studies. Five studies presented data for the associations between previous weight loss attempts and weight change at intervention's end (ranging from 6 to 48 weeks after baseline). A significant small effect size was found (r = 0.10; 95% CI 0.05–0.15), and there was evidence of moderate heterogeneity between studies (Q = 11.79, $p < 0.05$; $I^2 = 66\%$). The effects varied between studies. The study by Teixeira and colleagues [19] showed the largest effect size (r = 0.37), and the standard residual suggests this was an outlier (3.07). If this study was removed the overall effect size would decrease by 0.02, suggesting this study had no impact.

Higher (less realistic) weight loss goals/expectations were analyzed in 7 studies, with 56% of them reporting no significant association with weight loss and/or maintenance. Data on the associations between weight loss goals/expectations and weight change at intervention's end (ranging from 8 to 48 weeks after baseline) was available in 4 studies. A significant effect size was found (r = –0.07; 95% CI –0.11 to –0.02), suggesting that higher weight loss goals/expectations at the beginning of treatment might undermine successful weight loss. Yet, this effect was negligible and heterogeneity between studies very high (Q = 144.40, $p < 0.001$; $I^2 = 98\%$). The effects varied widely from study to study, and inspection of the standard residuals showed that the study conducted by Benyamini et al. [20] was an evident outlier (11.96). If this study was removed, the overall effect size would remain significant but the association would change direction (r = 0.09), suggesting that this study had a large impact on the overall effect size. Results from this review are therefore not clear about the direction of the association at this point.

Non-significant predictors: Numerous variables were identified as non-significant predictors in more than 66% of the times, namely most eating-related measures, depression symptoms, body shape concerns, exercise self-efficacy and social support, general quality of life, and self-esteem. Meta-analytic results supported these findings for most of these 11 predictors, with the exceptions of perceived hunger, depression symptoms, body shape concerns, exercise social support, general quality of life, and self-esteem, for which there was not sufficient data to perform the analysis. Eight studies presented data for the associations between eating self-efficacy and weight change at intervention's end (ranging from 4 to 48 weeks after baseline), and 5 studies for the association between binge eating and weight change at the same assessment point (ranging from 4 to 24 weeks after baseline). In both cases, non-significant very small effect sizes (r = 0.06; 95% CI –0.02 to 0.14, and r = 0.06; 95%

CI –0.01 to 0.13, respectively) and moderate heterogeneity between studies (Q = 18.61, p < 0.05; I^2 = 62%, and Q = 8.76, p > 0.05; I^2 = 54%, respectively) were found. The effects varied widely from study to study for eating self-efficacy; however, removing the three detected outliers (>1.96) led to no changes in the overall effect size. The studies testing binge eating showed similar effects, with the exception of the study conducted by Presnell et al. [21], which was an outlier (2.76); still, its removal did not change the overall effect size. Four studies presented data for the associations between either eating restraint or exercise self-efficacy, and weight change at intervention's end (varying from 16–48 weeks after baseline), and between eating disinhibition and weight change at follow-up's end (ranging from 60 to 144 weeks after intervention end). Non-significant negligible effects were found for all these predictors (r = –0.05; 95% CI –0.12 to 0.02, r = 0.05; 95% CI –0.02 to 0.12 and r = –0.03; 95% CI –0.13 to 0.07, respectively). Heterogeneity was very low for eating restraint and exercise self-efficacy (Q = 3.17, p > 0.05; I^2 = 5%, and Q = 1.90, p > 0.05; I^2 = 0%, respectively), and moderate for eating disinhibition (Q = 11.55, p < 0.05; I^2 = 74%). Inspection of standard residuals showed no outliers for eating restraint and exercise self-efficacy, but two outliers for eating disinhibition. If the two studies [22, 23] were removed, the overall effect size would increase and become significant (r = –0.24). After such removal, only two studies would remain, one of them of weak quality. Thus, results need to be interpreted with caution.

Variables examined in too few studies: Several variables were examined in too few studies (< 4) to allow reliable conclusions regarding their predictive value. These include motivational variables (e.g., autonomous and controlled motivations, weight control self-efficacy, perceived exercise barriers), obesity-specific quality of life, and perceived social support.

Sensitivity Analyses

Initial BMI: Sensitivity analyses showed that removing weak quality studies would lead to a slightly lower (*r* = 0.09) but non-significant overall effect size. Repeating the primary analysis without the studies requiring effect size estimation (N = 3) slightly increased the overall effect size to r = 0.17. Only including studies reporting absolute weight loss (in kg, N = 8) increased the overall effect size by 0.06; a non-significant effect due to lower power (p < 0.052). On the other hand, only including the two studies reporting percent weight loss would not be meaningful, given their small number and high heterogeneity (I^2 = 97%).

Previous weight loss attempts: Removing studies with estimated effect sizes (N = 1), or exclusively including studies reporting absolute weight loss (N = 3) did not change the overall effect size, suggesting that this finding was relatively consistent. There was only one study reporting percent weight loss precluding the repetition of the analysis for this type of studies. Publication biases were not tested because data from less than 10 studies were available [17].

Weight loss goals/expectations: Sensitivity analyses showed that removing the weak quality study did not change the overall effect size (r = –0.08; 95% CI - 0.12 to –0.04). There were no studies with estimated effect sizes or reporting percent weight loss. Publication biases could not be tested (N < 10) [17].

Eating- and exercise-related psychosocial predictors: Removing weak-quality studies did not change the overall effect size for eating self-efficacy (N = 1) and eating disinhibition (N = 2). Repeating the primary analysis without the estimated effect sizes did not change the overall effect size for eating self-efficacy, eating disinhibition, and exercise self-efficacy, but resulted in a 0.02 increase for binge eating (now significant; p = 0.040). Sensitivity analyses including studies reporting absolute weight loss did not led to changes in the overall effect size for eating and exercise self-efficacy, and increased the overall effect sizes for binge eating (from r = 0.06 to r = 0.15) and eating restraint (from r = –0.05 to r = –0.12), which became significant. Only including the two studies reporting percent weight loss did not change the overall effect size for eating restraint. Publication bias could not be tested for these predictors (N < 10) [17].

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Discussion

The aim of this systematic review and meta-analysis was to summarize the current research on pretreatment predictors of weight control in lifestyle obesity interventions. Our results indicate that previous weight control attempts were the most consistent pretreatment predictor of weight loss. Importantly, several variables, many of which were previously considered barriers for weight control, were identified as non-predictors in this review update. These include eating self-efficacy, binge eating, cognitive eating restraint, eating disinhibition, and exercise self-efficacy. However, more studies of high quality are needed to replicate these results.

Fewer previous dieting attempts were the most consistent predictor of successful weight loss. Mechanisms explaining why more previous dieting attempts impair future weight loss success remain poorly understood. Potential explanations include that a history of recurrent dieting attempts could be related to a psychological profile that is more vulnerable to failure, characterized by poor self-concept, body image disparagement, pessimistic attributions, and feelings of helplessness [24–26]. Also, repeated and restrictive dieting may lead to an obsession with food and trigger uncontrolled overeating [27], undermining successful weight management. In addition, a history of failed attempts might make subsequent weight loss harder from a physiological perspective, as a reduction of metabolic rate and loss of lean mass derived from the negative energy balance may facilitate post-dieting weight-rebound [28]. Also, individuals presenting a higher number of dieting attempts could have genetic or physiological characteristics that prompt weight gain [29]. Finally, age could be a moderating factor, as the number of attempts will likely increase with age (a person who started to diet when she was 20 will likely have had fewer dieting attempts by the age of 25 than a person who started dieting at 20 and is now 40). These findings highlight the importance of evaluating the number of previous weight loss attempts at the beginning of behavioral obesity interventions, as a way of identifying participants at-risk for lower success. These participants might particularly benefit from interventions increasing their confidence levels, uncovering hidden barriers, or exploring reasons for their desire to lose weight. To further understand the nature of this predictor, future research should use a standardized measure with regard to time frame and defining weight loss attempts (e.g., formally assisted, using dietary supplements etc.).

At first glance, our results suggest that higher (less realistic) weight loss goals/expectations at program's start could increase the chances of unsuccessful outcomes as well as the probability of dropout from any behavioral intervention, in line with previous research [30]. Importantly, high heterogeneity and many outliers preclude firm conclusions about the role of weight loss goals/expectations on subsequent weigh loss.

Factors that consistently did not predict weight loss include eating self-efficacy, binge eating and cognitive dietary restraint. One possible explanation for the lack of associations between pretreatment eating self-efficacy and subsequent weight loss might be related to the frequent disregard of its multiple dimensions and their differentiated role in weight loss [21]. In addition, the extent to which treatment is successful in actually increasing participants' self-efficacy during the intervention could in fact reduce the impact of pretreatment self-efficacy on weight loss. Regarding binge eating, one possible reason for this finding is the high variability in instruments used. For instance, the Binge Eating Scale [31], which was designed specifically for obese individuals and is well-validated, has only been used in half of the studies. It is also possible that important and positive changes in binge eating take place during the intervention, rendering the effects of pretreatment values irrelevant to the overall outcomes. One reason that cognitive eating restraint did not predict weight loss success might be its two contrasting dimensions, rigid and flexible restraint [32]. Rigid restraint is charac-

terized by an all-or-nothing approach to eating and weight management. Flexible restraint permits 'fattening' foods in limited quantities and better predicts successful weight loss than rigid restraint [33]. Importantly, none of the studies in the current review explored these separate aspects of restraint.

Overall, the literature on pretreatment predictors of weight loss success can be considered mixed at best. Potential explanations for the few consistent psychosocial pretreatment predictors for weight loss success could be the great heterogeneity observed across the available studies, which differed considerably in sample sizes, treatment modalities (e.g., type of diet), length, format, and style of intervention delivery. The use of variable (and sometimes inadequate) measures of psychosocial pretreatment characteristics might also have contributed to the high variability of results.

Limitations

The present review has a number of limitations. First, the number of studies per predictor included in this review is often small and thus reduces statistical power [11]. Second, we found a high level of heterogeneity between studies, which could not be explained with moderator analyses due to the limited number of studies. Third, publication bias could not be examined for any of the eight predictors with sufficient data for meta-analyses due to the limited number of studies (<10). Fourth, different outcome formats were included in the same meta-analysis to avoid loss of information and a biased sample of studies [11]. Fifth, effects are based on data from completers, as most studies did not perform intent-to-treat analyses. Sixth, given that correlational data were also used, we cannot exclude reverse causality. Finally, unpublished studies were not included, potentially omitting mainly non-significant findings.

Conclusion

This review summarizes the evolution of research on pretreatment predictors of weight loss over the last decade. Fewer previous weight loss attempts was the most consistent pretreatment predictor of weight loss in the literature. Also, numerous potential predictors were identified as non-significant predictors, including eating self-efficacy, binge eating or cognitive eating restraint, suggesting that overweight/obese individuals might successfully manage their weight even if initially presenting unfavorable scores on these predictors. While effects of psychosocial pretreatment predictors on weight control were generally small, it is important to note that even a small weight loss can have large public health consequences such as notably improved cardiovascular risk factors [34]. Nevertheless, more high-quality studies are needed to draw more reliable conclusions about the role of these factors. It seems too early to tailor interventions based on pretreatment psychosocial characteristics. Still, assessing these characteristics could be useful to increase participants' awareness of their motivations and perceptions, and help identifying factors that may be important for their personal weight loss process. Prior research has shown that considering participants' views when making treatment decisions in obesity treatment, such as personal preferences or reasons to engage in treatment, increases weight loss success [35] and should therefore be the standard in weight loss interventions.

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Disclosure Statement

The authors have no competing interests..

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