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Treatment-associated Improvements in Self-regulation and Mood as Theory-based Correlates of Increased Self-efficacy for Weight-management Behaviors

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Keywords

obesity, weight loss, self-regulation, self-efficacy, mood, exercise

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Abstract

Expanded understanding of the psychosocial dynamics of weight-loss treatment processes is required to improve consistently poor results. Women with obesity of ages 40–59 years participated in self-regulation-based ($n = 41$) and information-based ($n = 46$) treatments. Improvements in self-regulation and self-efficacy related to exercise and eating, mood, exercise, intake of fruits/vegetables and sweets, and weight were significant, and generally greater in the self-regulation group. Exercise- and eating-behavior changes significantly mediated the prediction of self-efficacy changes by changes in self-regulation, with mood change significantly adding to the prediction strength. Findings suggested the value in supporting exercise for its psychosocial benefits within weight-loss treatment.

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Advancement in the comprehension of the psychosocial dynamics of the weight-loss process is required to improve the preponderance of behavioral treatments failing to facilitate sustained success (Jeffery et al., 2000; MacLean et al., 2015; Mann et al., 2007). Although some intervention models based on accepted theory and/or research have been explored, refinements based on emergent data, especially in the area of mediators and moderators, are needed (Annesi & Marti, 2011; Baker & Brownell, 2000; Baranowski, 2006; Teixeira et al., 2015). To explain weight loss through treatment-associated psychosocial changes, relationships between self-regulation and self-efficacy through incremental performance accomplishments related to exercise and eating improvements have been proposed (Annesi & Marti, 2011). Additionally, it was posited that changes in mood would further enhance self-efficacy improvements in those weight-loss behaviors through "a healthier psychological climate" (Baker & Brownell, 2000, p. 320).

Those projected relationships are consistent with tenets of self-efficacy theory (Bandura, 1997), which suggests that self-efficacy beliefs are affected by performance accomplishments, and moods and emotions. To best utilize self-efficacy theory for the ultimate construction/refinement of a robust behavioral model of weight-loss useful for the development of reliable and effective treatment architectures, the present brief investigation was conducted. Women of ages 40–59 years were selected for participation because that subgroup demonstrated the greatest prevalence in each grade of obesity severity in the United States (Ogden, Carroll, Kit, & Flegal, 2014). The study's field setting incorporated self-regulation- and information-focused weight-management treatments in the hopes of providing data about where the areas of mental health, human physiology, and nutrition intersect to impact obesity. The following hypotheses were tested:

1. The self-regulation focused treatment will be associated with significantly greater improvements in the psychosocial measures of self-regulation, mood, and self-efficacy; the behavioral measures of exercise and intake of fruits/vegetables and sweets; and weight, compared with the information-based treatment.

2. Changes in the behavioral measures and weight will significantly mediate the prediction of self-efficacy changes by changes in self-regulation.
3. Group will significantly moderate the self-regulation change–self-efficacy change relationship.
4. Change in mood will significantly contribute to the prediction of self-efficacy change by change in self-regulation.

Method

Participants

The volunteer participants were a subgroup from longitudinal research in the United States still in the data-collection phase with aims different than the present investigation. For this study, inclusion criteria were females of ages 40–59 years, with a body mass index (BMI) ≥ 30 kg/m^2 (clinically obese), and no psychotropic medication use or contraindications for full participation. Sample size was determined by a power analysis (see the *Data analyses* subsection). Assignment to the self-regulation group ($n = 41$) and the information-based group ($n = 46$) was based on simple randomization, and there was no significant between-group difference in age (overall $M = 50.6$ years, $SD = 5.2$), BMI ($M = 35.3$kg/m^2, $SD = 3.3$) or ethnicity (overall 85% white, 10% black, 5% other). Nearly all participants were in the middle family-income range of US$50,000–$100,000/year. Institutional review board (IRB) approval was received prior to study initiation. Written informed consent was required for participation.

Measures

The measurement of self-regulation consisted of two 10-item scales that focused on respondents' present self-regulation of exercise (e.g., "I set physical activity goals") and self-regulation of eating (e.g., "I say positive things to myself about eating well") (Annesi & Marti, 2011). Response options ranged from 1 (*never*) to 4 (*often*), and were summed. In adults with obesity, internal consistencies were Cronbach's $\alpha = .81$ and .79, and test-retest reliabilities over 2 weeks were .74 and .78, respectively (Annesi & Marti, 2011). For the present sample, $\alpha = .85$ and .83, respectively. Self-regulation-merged was the sum of the above two scales. It was intended to present a unified assessment of participants' usage of self-regulation for the weight-loss behaviors of exercise and eating.

The measurement of self-efficacy also consisted of two scales. The Exercise Self-Efficacy Scale (e.g., "I am confident I can participate in regular exercise when I am tired") had 5 items with response options ranging from 1 (*not at all confident*) to 11 (*very confident*) (Marcus, Selby, Niaura, & Rossi, 1992). Internal consistencies were Cronbach's $\alpha = .76$–.82, and test-retest reliabilities over 2 weeks were .74–.78 (Marcus et al., 1992). For the present sample, $\alpha = .83$. Self-efficacy for eating was measured using the 20-item Weight Efficacy Lifestyle Scale, which addressed obstacles to controlling eating related to social pressures, positive activities, physical discomforts, high food availabilities, and negative emotions (e.g., "I can resist eating even when I am depressed or feeling down") (Clark, Abrams, Niaura, Eaton, & Rossi, 1991). Response options ranged from 0 (*not confident*) to 9 (*very confident*), and were summed. Internal consistencies within item clusters were Cronbach's $\alpha = .76$–.82 (Clark et al., 1991), and were $\alpha = .74$–.85 in the present sample. Self-efficacy-merged was the sum of above two scales. It was

intended to present a unified assessment of participants' self-efficacy related to the weight-loss behaviors of exercise and controlled eating.

Negative mood was measured using the 30-item Profile of Mood States Brief Form (McNair & Heuchert, 2009). Item clusters related to feelings of anxiety, fatigue, anger, confusion, vigor, and depression (e.g., "gloomy") over the past 2 weeks. Response options ranged from 0 (*not at all*) to 4 (*extremely*), and were summed after reversing vigor-related item responses. Internal consistencies of item groupings were Cronbach's α = .84–.95, and test-retest reliabilities over 3 weeks averaged .69 (McNair & Heuchert, 2009). For the present sample, α = .85–.93.

Exercise sessions (≥ 15 min) completed over the previous week were measured using the Leisure-time Physical Activity Questionnaire (Godin, 2011). Number of bouts associated with an energy expenditure expressed in metabolic equivalents (MET = 3.5mL of O_2/kg/min) ranging from mild (3 METs; e.g., easy walking) to strenuous (9 METs; e.g., running) were recorded, then summed. Concurrent validity was indicated through correspondences with treadmill test (β = .57, $p < .001$) and accelerometer (β = .45, $p < .001$) values (Jacobs, Ainsworth, Hartman, & Leon, 1993; Pereira et al., 1997). Test-retest reliability over 2 weeks was .74 (Pereira et al., 1997).

Daily intake of fruits (e.g., pear, orange [one small, or 118 mL]), vegetables (e.g., carrots, peas [118 mL]), and sweets (e.g., cake [one small piece, or 59 mL]) consumed over the past week corresponded to U.S. Department of Agriculture (2017) portion sizes. Scores from fruits and vegetables were summed. Correlations of the present brief recall survey with comprehensive food frequency recall instruments and the Block Food Frequency Questionnaire were strong at .70–.85, and test-retest reliabilities over 3 weeks were .77–.83 in women with obesity (Block et al., 1986; Mares-Perlman et al., 1993).

After footwear and heavy outer-clothing were removed, study staff recorded the mean of two consecutive measurements of weight using a recently calibrated digital scale.

Procedure

Both weight-loss treatments within this study lasted 6 months. Under the guidance of study staff, they were administered by existing staff members of community wellness facilities who had appropriate national certifications and trainings in the present protocols. The self-regulation treatment was based on social cognitive and self-efficacy theory, and the building of self-regulatory skills. Its exercise-support component incorporated a curriculum of six, one-on-one meetings (45 min/session) that taught and rehearsed skills such as proximal goal setting, cognitive restructuring, relapse prevention, stimulus control, dissociation from discomfort, and behavioral contracting to overcome actual and perceived barriers (Annesi & Marti, 2011). Its nutrition component began 2 months after initiating exercise support, met every 2 weeks (60 min/session), and required food/calorie logging and weekly self-weighing. It was administered in groups of 10–15 participants, and primarily sought to generalize the self-regulatory skills used to support exercise to eating changes such as increased intake of fruits/vegetables (an established proxy for the overall health of one's diet; Rolls, Ello-Martin, & Tohill, 2004) and reduced intake of sweets.

The information-based treatment communicated information related to increasing exercise and improving eating behaviors. It consisted of 15-min phone conversations between an instructor and a participant every 2 weeks, which was after the participant reviewed a designated section of written material. Example topics were healthy snacking, vegetables in the diet, and

individualizing an exercise program. The use of self-management was also addressed within the written materials and phone conversations.

For both treatment conditions, the government-established recommendation of ≥ 150 min/week of moderate exercise (Garber et al., 2011) was mentioned; however, possible benefits of lesser amounts were also acknowledged. Structured fidelity assessments were completed by study staff on approximately 15% of treatment sessions. They indicated a high degree of protocol compliance.

Data Analyses

Criteria for data being missing-at-random (White, Horton, Carpenter, & Pocock, 2011) were met. The expectation-maximization algorithm imputed the 15% of missing cases, which enabled an intention-to-treat format. For the primary analyses, a sample size of 84 was required to detect a moderate effect ($f^2 = .15$) at the statistical power of .80 ($\alpha < .05$) (Cohen, Cohen, West, & Aiken, 2003). SPSS Statistics Version 22 (IBM, Armonk, NY) incorporated macroinstruction applications with 20,000 bootstrapped resamples (Hayes, 2015). Statistical significance was set at $\alpha < .05$, throughout. Because of consistent directionality in relationships among the study's variables in previous research (Annesi & Marti, 2011; Teixeira et al., 2015), regression analyses were one-tailed. All others were two-tailed.

Within-group t-tests and mixed-model repeated-measures analyses of variances (ANOVAs) assessed significance of score changes from Time 1 to Time 2, and whether those changes significantly differed by group. The planned lagged variable format required Time 2 to represent Month 3 data for the self-regulation and mood measures (independent variables), and Month 6 data for all others. Effect sizes were calculated as Cohen's d ($[M_{Time2} - M_{Time1}]/SD_{Time1}$) for dependent t-tests, and partial eta-square ($\eta^2_p = SS_{Effect}/[SS_{Effect} + SS_{Error}]$) for the time × group AVOVAs. Values of .06, .14, .20, and .20, .50, .80, represented small, moderate, and large effects, respectively.

After aggregating group data, four mediation models were fit where the change in a weight-loss behavior/weight was tested for its mediation of the prediction of self-efficacy change by self-regulation change (Figure 1). After those analyses, group (coded: 1 = self-regulation group, 2 = information group) was added to the above models to assess its moderation of the prediction of self-efficacy change by self-regulation change.

Finally, hierarchical multiple regression models were fit, which first tested predictions of self-efficacy changes by self-regulation changes. In Step 2 of those equations, mood change was entered to determine if it significantly added predictive strength (designated by ΔR^2), as suggested by theory (Bandura, 1997).

Results

There were no significant baseline differences, by group. Improvements on all measured variables were significant in each group (Table 1). The greater improvements in the self-regulation group were significant for self-regulation of exercise, $F(1, 85) = 16.59$, $p < .001$, $\eta^2_p = .16$; self-efficacy for eating, $F(1, 85) = 4.15$, $p = .045$, $\eta^2_p = .05$; self-regulation-merged, $F(1, 85) = 10.85$, $p = .001$, $\eta^2_p = .11$; self-efficacy-merged, $F(1, 85) = 4.98$, $p = .028$, $\eta^2_p = .06$; exercise, $F(1, 85) = 10.63$, $p = .002$, $\eta^2_p = .11$; fruit/vegetable intake, $F(1, 85) = 8.53$, $p = .004$, $\eta^2_p = .09$;
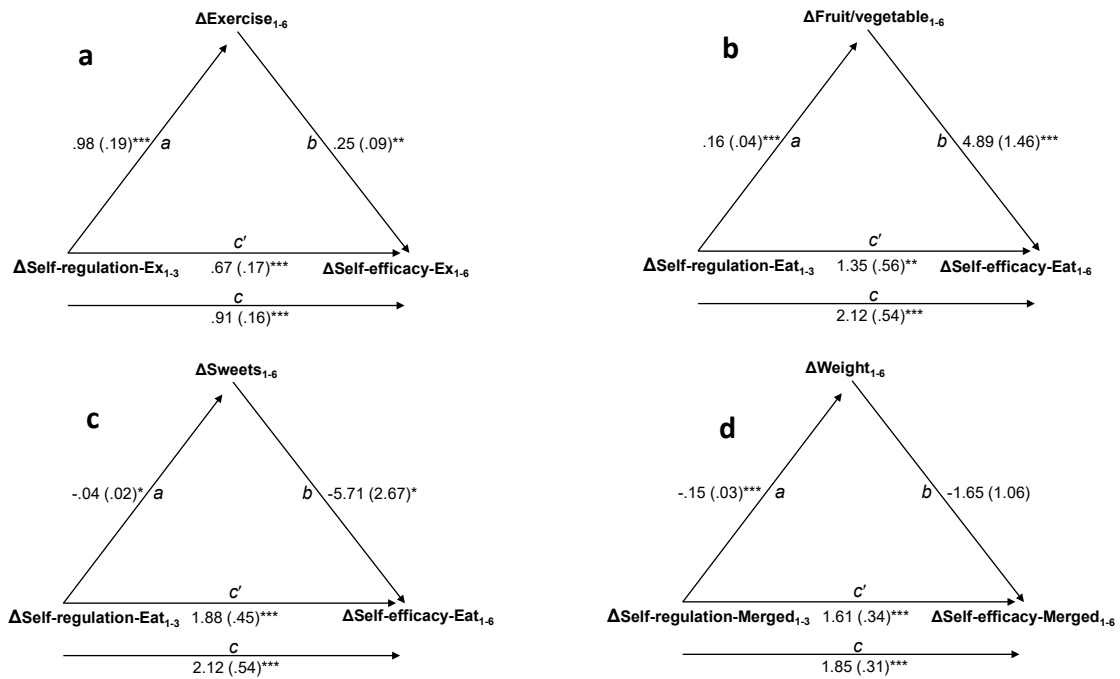
Figure 1. Exercise (**a**), fruits/vegetables (**b**), sweets (**c**), and weight (**d**) as mediators of predictions of self-efficacy changes by self-regulation changes
Δ = change in score. Subscript 1-3 = baseline–Month 3, subscript 1-6 = baseline–Month 6. Ex = exercise. Eat = eating. Path *a*, *b*, *c'*, and *c* data are expressed as B (SE_B).
p < .05. **p* < .01. ***p* < .001.

Table 1

Changes in Study Variables, by Group

	Time 1		Time 2		Score change		t	p	95%CI	d
	M	SD	M	SD	M	SD				
Self-regulation-exercise										
Self-regulation group	22.44	6.53	32.56	4.67	10.12	7.90	8.20	<.001	7.62,12.62	1.55
Information-based group	22.83	6.64	27.24	6.32	4.41	4.99	6.00	<.001	2.93, 5.90	0.66
Aggregated	22.64	6.55	29.75	6.18	7.10	7.09	9.34	<.001	5.59, 8.62	1.08
Exercise self-efficacy										
Self-regulation group	25.37	7.62	34.78	11.89	9.41	11.84	5.09	<.001	5.68, 13.15	1.20
Information-based group	21.67	9.61	26.30	12.65	4.63	11.98	2.62	.012	1.07, 8.19	0.48
Aggregated	23.41	8.87	30.30	12.95	6.89	12.08	5.31	<.001	4.31, 9.46	0.78
Self-regulation-eating										
Self-regulation group	24.15	5.72	32.13	4.40	7.99	6.78	7.55	<.001	5.85, 10.13	1.40
Information-based group	22.07	6.00	27.54	5.39	5.48	5.72	6.50	<.001	3.78, 7.18	0.91
Aggregated	23.05	5.93	29.71	5.43	6.66	6.33	9.82	<.001	5.31, 8.01	1.12
Self-efficacy-eating										
Self-regulation group	89.22	32.14	126.87	28.93	37.65	36.06	6.69	<.001	26.27, 49.03	1.17
Information-based group	88.30	33.28	111.30	28.38	23.00	31.03	5.03	<.001	13.79, 32.21	0.69
Aggregated	88.74	32.56	118.64	29.52	29.90	34.09	8.18	<.001	22.64, 37.17	0.92
Self-regulation-merged										
Self-regulation group	49.59	11.13	64.70	7.93	18.11	13.75	8.43	<.001	13.77, 22.45	1.63
Information-based group	44.89	11.37	54.78	10.33	6.89	9.31	7.20	<.001	7.13, 12.66	0.87
Aggregated	45.69	11.22	59.45	10.48	13.76	12.26	10.47	<.001	11.15, 16.38	1.23
Self-efficacy-merged										
Self-regulation group	115.80	38.06	162.87	38.52	47.06	45.02	6.69	<.001	32.85, 61.27	1.24
Information-based group	109.98	36.62	137.61	34.89	27.63	36.13	5.19	<.001	16.90, 38.36	0.75
Aggregated	112.72	37.20	149.51	38.57	36.79	41.48	8.27	<.001	27.95, 45.63	0.99
Negative mood										
Self-regulation group	24.95	15.01	10.16	15.73	-14.79	14.36	6.60	<.001	-10.26, -19.32	0.99
Information-based group	21.93	11.43	12.20	8.17	-9.74	10.03	6.59	<.001	-12.72, -6.76	0.85
Aggregated	23.36	13.24	11.24	12.29	-12.12	12.45	9.08	<.001	-14.77, -9.47	0.92
Exercise (METs/week)										
Self-regulation group	8.15	7.56	31.93	16.43	23.78	15.73	9.68	<.001	18.81, 28.75	3.15
Information-based group	8.93	7.32	23.43	12.63	14.50	10.57	9.30	<.001	11.36, 17.64	1.98
Aggregated	8.56	7.40	27.44	15.07	18.87	13.98	12.60	<.001	15.89, 21.85	2.95
Fruit/vegetable intake (portions/day)										
Self-regulation group	3.62	2.02	6.56	2.27	2.94	2.48	7.59	<.001	2.16, 3.72	1.46
Information-based group	3.32	1.91	4.77	2.29	1.46	2.26	4.37	<.001	0.79, 2.13	0.76
Aggregated	3.46	1.95	5.61	2.44	2.16	2.47	8.15	<.001	1.63, 2.68	1.11
Sweets intake (portions/day)										
Self-regulation group	1.96	1.30	0.96	0.79	-1.00	1.36	4.69	<.001	-1.43, -0.57	0.77
Information-based group	2.07	1.73	1.51	1.28	-0.55	1.16	3.24	.002	-0.90, -0.21	0.32
Aggregated	2.02	1.53	1.25	1.11	-0.76	1.27	5.60	<.001	-1.04, -0.49	0.50
Weight (kg)										
Self-regulation group	94.89	11.15	89.28	11.22	-5.61	3.97	9.06	<.001	-6.87, -4.36	0.50
Information-based group	95.74	10.88	93.56	10.72	-2.18	3.25	4.55	<.001	-3.15, -1.22	0.20
Aggregated	95.34	10.95	91.54	11.10	-3.80	3.98	8.91	<.001	-4.65, -2.95	0.35

Note. Self-regulation group $n = 41$ ($df = 40$). Information-based group $n = 46$ ($df = 45$). Aggregated $N = 87$ ($df = 86$). Time 2 represents Month 3 data for the self-regulation and mood measures, and Month 6 data for all other measures. Score change = Time 2-Time 1. 95% CI = 95% confidence interval. d = Cohen's d measure of effect size (M_{Time2} - M_{Time1}/SD_{Time1}).

and weight, $F(1, 85) = 19.64$, $p < .001$, $\eta^2_p = .19$. Although not reaching statistical significance, all other differences were $p \leq .10$.

Results of mediation analyses (Figure 1, a–d) indicated significant mediation by increase in the applicable health behavior in each of the four analyses, $B = .24$, $SE_B = .10$, 95% CI [.10, .42], $B = .77$, $SE_B = .34$, 95% CI [.33, 1.41], $B = .24$, $SE_B = .16$, 95% CI [.05, .60], and $B = .24$, $SE_B = .16$, 95% CI [.02, .53]; with overall model R^2s = .35, .25, .20, and .32, respectively, ps < .001. Moderation of group in the prediction of self-efficacy change by self-regulation change was significant only in the prediction of change in self-efficacy for exercise, $B = -.81$, $SE_B = .36$, $p = .014$, 95% CI [-1.41, -0.21].

Entry of mood change significantly added to the significant (ps < .001) prediction of changes in self-efficacy for eating, $\Delta R^2 = .04$, $p = .018$, and self-efficacy-merged, $\Delta R^2 = .03$, $p = .040$, but not self-efficacy for exercise, $\Delta R^2 = .003$, $p = .271$, by changes in the corresponding self-regulation measure. Overall model R^2s = .20, .33, and .29, respectively, ps < .001.

Discussion

This brief report clarified interrelationships between changes in select self-efficacy theory-related variables, and aided comprehensive model development. This in turn could lead to the translation of that theory into an effective architecture for behavioral weight-loss treatment architectures usable in both individual counseling and community-based applications (Baranowski, 2006). An emphasis on self-regulatory skills development, rather than the typical transfer of instruction in desirable exercise and healthy eating practices, was supported for both the psychological and behavioral measures assessed. Additionally, self-regulation-supported improvements in both exercise and eating behaviors facilitated increased self-efficacy. Therefore, enabling feedback on even minimal progress in weight-loss behaviors is suggested. Finally, the finding that improved mood moderated the eating self-regulation–eating self-efficacy change relationships suggests that efforts to carefully support exercise for its mood-enhancement properties is warranted – possibly even *prior to* focusing on eating behavior changes. The results extend previous research on mediation effects of self-regulation- and self-efficacy-related variables in regard to weight loss, which were mostly limited to cross-sectional data (see Teixeira et al., 2015 for a review).

Limitations of this research included a specific volunteer sample. Thus, replication is required across genders, age groups, ethnicities, and medical conditions (e.g., diabetes). Additionally, longer-term effects require analyses. The field design encompassing different degrees/lengths of interactions by instructors and fellow participants challenged internal validity such as through expectation and social support effects. However, the field setting was also a strength because findings could be readily generalized to large-scale, community-based settings. Hopefully, continued related research will ultimately facilitate greater and more reliable weight-reduction outcomes.

Implications for Health Behavior Theory

Findings suggested the value of supporting exercise for its psychosocial benefits, and clarified interrelations of self-regulation, mood, and self-efficacy within behavioral treatments. Thus, data were provided for both the extension of theory and practical applications regarding the treatment of obesity. Findings suggested that sufficient weight-loss treatment attention be

paid to supporting moderate exercise and the development of an array of self-regulatory skills. Extensions of this research should evaluate obesity treatments guided by the most salient behavioral theory and research.

Discussion question

What are the interrelations of changes in self-efficacy, self-regulation, and mood within a cognitive-behavioral weight-management intervention that emphasizes exercise?

Acknowledgments

References

Annesi, J. J., & Marti, C. N. (2011). Path analysis of exercise treatment-induced changes in psychological factors leading to weight loss. *Psychology and Health, 26*(8), 1081–1098. https://doi.org/10.1080/08870446.2010.534167

Baker, C. W., & Brownell, K. D. (2000). Physical activity and maintenance of weight loss: Physiological and psychological mechanisms. In C. Bouchard (Ed.), *Physical activity and obesity* (pp. 311–328). Champaign, IL: Human Kinetics.

Bandura, A. (1997). *Self-efficacy: The exercise of control*. New York, NY: Freeman.

Baranowski, T. (2006). Advances in basic behavioral research will make the most important contributions to effective dietary change programs at this time. *Journal of the Academy of Nutrition and Dietetics, 106*, 808–811. https://doi.org/10.1016/j.jada.2006.03.032

Block, G., Hartman, A. M., Dresser, C. M., Carroll, M. D., Gannon, J., & Gardner, L. (1986). A data-based approach to diet questionnaire design and testing. *American Journal of Epidemiology 124*(3), 453–469. https://doi.org/10.1093/oxfordjournals.aje.a114416

Clark, M. M., Abrams, D. B., Niaura, R. S., Eaton, C. A., & Rossi, J. S. (1991). Self-efficacy in weight management. *Journal of Consulting and Clinical Psychology, 59*(5), 739–744. https://doi.org/10.1037//0022-006x.59.5.739

Cohen, J., Cohen, P., West, S. G., & Aiken, L. S. (2003). *Applied multiple regression/correlation analysis for the behavioral sciences* (3rd ed.). Mahwah, NJ: Erlbaum.

Garber, C. E., Blissmer, B., Deschenes, M. R., Franklin, B. A., Lamonte, M. J., Lee, I. -M., … Swain, D. P. (2011). Quantity and quality of exercise for developing and maintaining cardiorespiratory, musculoskeletal, and neuromotor fitness in apparently healthy adults: Guidance for prescribing exercise. *Medicine and Science in Sports and Exercise, 43*(7), 1334–1359. https://doi.org/10.1249/MSS.0b013e318213fefb

Godin, G. (2011). The Godin-Shephard Leisure-time Physical Activity Questionnaire. *Health & Fitness Journal of Canada, 4*(1), 18–22.

Hayes, A. F. (2015). An index and test of linear moderated mediation. *Multivariate Behavioral Research, 50*(1), 1–22. https://doi.org/10.1080/00273171.2014.962683

Jacobs, D. R., Ainsworth, B. E., Hartman, T. J., & Leon, A. S. (1993). A simultaneous evaluation of 10 commonly used physical activity questionnaires. *Medicine & Science in Sports & Exercise, 25*(1), 81–91. https://doi.org/10.1249/00005768-199301000-00012

Jeffery, R. W., Epstein, L. H., Wilson, G. T., Drewnowski, A., Stunkard, A. J., & Wing, R. R., & Hill, D. R. (2000). Long-term maintenance of weight loss: Current status. *Health Psychology, 19*(Suppl. 1), 5–16. https://doi.org/10.1037/0278-6133.19.Suppl1.5

MacLean, P. S., Wing, R. R., Davidson, T., Epstein, L., Goodpaster, B., Hall, K. D., … Ryan, D. (2015). NIH working group report: Innovative research to improve maintenance of weight loss. *Obesity, 23*(1), 7–15. https://doi.org/10.1002/oby.20967

Mann, T., Tomiyama, A. J., Westling, E., Lew, A.-M., Samuels, B., & Chatman, J. (2007). Medicare's search for effective obesity treatments: Diets are not the answer. *American Psychologist, 62*(3), 220–233. https://doi.org/10.1037/0003-066X.62.3.220

Marcus, B. H., Selby, V. C., Niaura, R. S., & Rossi, J. S. (1992). Self-efficacy and the stages of exercise behavior change. *Research Quarterly for Exercise and Sport, 63*(1), 60–66. https://doi.org/10.1080/02701367.1992.10607557

Mares-Perlman, J. A., Klein, B. E. K., Klein, R., Ritter, L. L., Fisher, M. R., & Freudenheim, J. L. (1993). A diet history questionnaire ranks nutrient intakes in middle-aged and older men and women similarly to multiple food records. *The Journal of Nutrition, 123*(3), 489–501. https://doi.org/10.1093/jn/123.3.489

McNair, D. M., & Heuchert, J. W. P. (2009). *Profile of Mood States technical update*. North Tonawanda, NY: Multi-Health Systems.

Ogden, C. L., Carroll, M. D., Kit, B. K., & Flegal, K. M. (2014). Prevalence of childhood and adult obesity in the United States, 2011-2012. *Journal of the American Medical Association, 311*(8), 806–814. https://doi.org/10.1001/jama.2014.732

Pereira, M. A., FitzGerald, S. J., Gregg, E. W., Joswiak, M. L., Ryan, W. J., Suminski, R. R., … Zmuda, J. M. (1997). A collection of physical activity questionnaires for health-related research. *Medicine & Science in Sports & Exercise, 29*(6Suppl), S1–S205.

Rolls, B. J., Ello-Martin, J. A., & Tohill, B. C. (2004). What can intervention studies tell us about the relationship between fruit and vegetable consumption and weight management? *Nutrition Reviews, 62*(1)*,* 1–17. https://doi.org/10.1111/j.1753-4887.2004.tb00001.x

Teixeira, P. J., Carraça, E. V., Marques, M. M., Rutter, H., Oppert, J. -M., De Bourdeaudhuij, I., … Brug, J. (2015). Successful behavior change in obesity interventions in adults: A systematic review of self-regulation mediators. *BMC Medicine, 13*, 84. https://doi.org/10.1186/s12916-015-0323-6

U.S. Department of Agriculture. (2017). *MyPlate and historical Food Pyramid resources*. Beltsville, MD: National Agricultural Library.

White, I. R., Horton, N. J., Carpenter, J., & Pocock, S. J. (2011). Strategy for intention to treat analysis in randomised trials with missing outcome data. *British Medical Journal, 342*, d40. https://doi.org/10.1136/bmj.d40