The Effects of If-Then Plans on Weight Loss: Results of the 24-Month Follow-up of the McGill CHIP Healthy Weight Program Randomized Controlled Trial

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Research

Keywords: Lifestyle modifications, Weight-loss, Behavior modifications, Clinical trials, Diabetes

Posted Date: September 16th, 2019

DOI: https://doi.org/10.21203/rs.2.13711/v1

Version of Record: A version of this preprint was published on January 7th, 2020. See the published version at https://doi.org/10.1186/s13063-019-4014-z.

Abstract

Background: The NIH-developed Diabetes Prevention Program (DPP) is successful in achieving clinically significant weight loss in individuals with overweight/obesity when delivered one-on-one. However, due to high cost of implementation, the long-term effectiveness remains limited. In response, a group-based version of the program, called the National DPP, was developed. The average weight loss following participation in this program was only about 3.5% with low long-term weight loss maintenance. Purpose: We aimed to optimize weight loss outcomes of the National DPP by integrating the habit formation tool of if-then plans into the program. Results at 3 and 12 months of participation showed no between-group differences between standard and enhanced DPP but higher weight loss in both groups compared to the National DPP. This paper reports the long-term weight loss maintenance data following participation in the program. Methods: Of the 172 participants enrolled at the beginning of the study, data from 110 participants was available and analyzed at 24 months, i.e. 12 months following the end of the 12-month intervention. Results: No between-group difference in weight loss maintenance was seen. Pooled results showed a significant weight regain from 12 to 24 months, i.e. an average of 7.85lbs of the 20.36lbs lost. However, participants from both groups were still 12lbs or 6.13% lighter at 24 months than at baseline. Conclusion: If-then plans did not result in a higher percentage of weight loss at 24-month follow-up. However, at 24 months, both groups maintained a significant portion of the weight lost at the end of intervention.

Background

Behavior modification programs aimed at changing diet and physical activity have been shown to be an effective weight loss approach (1). The most effective among these has been the one-on-one Diabetes Prevention Program (DDP) (2) for which clinically significant weight loss of 5–7% and a reduction in diabetes by 58% compared to placebo has been found at an average three years post-intervention (3). Participants in this program displayed modest weight regain (e.g., 2.2lbs); however, diabetes incidence remained lower at 10-year follow-up (4).

Due to the high cost of the one-on-one DPP, a group-based shortened version, called the National DPP, was developed (5). While less costly to implement and thus more accessible, its effectiveness is lower than the one-on-one DPP. A recent meta-analysis showed that weight loss with the National DPP was 3.99% at post-intervention compared to 7% with the one-on-one DPP (6). One of the few National DPP intervention studies that provide longer term weight loss maintenance data found that the probability of achieving a 5% weight loss at 3 months was 45.7%, but only 17.3% maintained this weight loss one year post-intervention (7; Piatt et al. reported these numbers in probabilities instead of actual percentages of weight loss. We reached out to the authors for clarification but did not receive a response.) Also, of those who lost at least 5% of their body weight post-intervention, 52.6% maintained it at 24 months, weighing about 20lbs less than at baseline (7).

To increase the weight maintenance effectiveness of the National DPP, our study integrated habit formation techniques, specifically if-then plans, to reinforce habit change (8,9). If-then plans (also called implementation intentions) are concrete contingency plans that specify when, where, and how to act in a specific situation (8,9). If-then plans have demonstrated medium to large effects in inducing habit change in a number of behaviors (10). Not many long-term studies of implementation intentions and complex behaviors yet exist.

The 3- and 12- (end of intervention) month results of the if-then enhanced randomized controlled trial (RCT) have been published (11). No between-group differences were found; however, both groups displayed significant weight loss, losing an average of 9.98% over 12 months. The lack of significant group differences was hypothesized to be

the result of several factors, specifically, the implicit creation of if-then plans by the control group participants and the coaches highly trained in cognitive behavioral therapy (CBT) (11).

This paper reports the findings of our RCT after a 1-year no-contact follow-up period. We hypothesized that the if-then plans would serve as a protective barrier to weight regain. Specifically, we hypothesized that from the end of intervention (12 months) to 24 months, the if-then plan group would show greater weight loss maintenance than the group that was not explicitly instructed to create if-then plans.

Method

The prospective, two-arm RCT was conducted between 2014 and 2017 with approval by the Research Ethics Board at McGill University (Montreal, Canada). A detailed description of the intervention, methods, procedures, and measures are published in the study protocol (12) and outlined in Figure 1. Informed consent was obtained from all participants before any study procedures were conducted.

Study Procedures

The National DPP manual was adhered to in both groups (5) and if-then plans were integrated into sessions of the enhanced groups. Of the 172 participants who were enrolled at the beginning of the study, we were able to collect data from 110 participants at 24-month follow-up (64% retention; 51 in the enhanced National DPP group and 59 in the control National DPP group)

Measures

The primary outcome, body weight, was assessed using a digital scale. Details of the measures of the secondary outcomes of goal achievement, diabetes risk factors, physical activity, self-monitoring, and habit strength are available in the study protocol (12). Self-monitoring of food and exercise was completed through an online tracker. Habit strength was assessed using the Self-Report Index of Habit Strength (13).

Statistical Analyses

Study analyses were conducted using Mplus version 8.0 (14). Multigroup analysis was used to examine change (i.e., mean difference) from the 12- to 24-month follow-up. As with the previous analysis (11), missing data for N = 62 participants was handled with the estimation procedure “use full information maximum likelihood” with robust standard errors. This allows all data to be included in the estimation (15,16). As such, the missing data were imputed internally in the same model examining change in weight over time. Missing weight measurements were then predicted from other weight measurements assessed at other time points. As Little’s missing completely at random test was not significant (P = 0.608), the missingness was assumed to follow an MCAR pattern. The full information maximum likelihood method performs equally well as listwise (or pairwise) deletion under MCAR (16). The group difference was assessed using the rescaled −2 log likelihood difference test, which is distributed as chi-squared with degrees of freedom equal to the rescaled difference in the number of parameters between models. Specifically, the group difference was examined by comparing the fit of a model in which the change from 12 to 24 months was permitted to differ between groups with the fit of a model in which the change was restricted to be equal in both groups. A non-significant chi-square test value at α =.05 indicated no group difference in the

estimate examined. Due to the non-significant model difference, average pooled change scores were computed across groups.

Results

Information about baseline demographics and completed measures are reported in the 3- and 12-month results paper and the protocol paper, respectively (11,12). Mean changes in all study outcomes from 12 to 24 months are reported in Table 1. Chi-square values indicate that mean changes for all variables did not differ between groups.

Primary Outcome

Table 2 contains the means at baseline and 12 months and mean changes pooled across the two groups. Pooled results show a significant weight regain from 12 to 24 months, with participants regaining on average 7.85lbs of the 20.36lbs that they had lost. However, participants were still 12lbs (or 6.13%) lighter at 24 months than at baseline. More than half of all participants who achieved a clinically significant weight loss of 5% at post-intervention maintained this weight loss at 24 months.

Secondary Outcomes

Pooled results showed significant changes only for self-monitoring and habit strength. All other variables showed no significant change from 12 to 24 months, i.e., all changes achieved by 12 months were maintained.

Self-Monitoring. Food tracking frequency significantly decreased for both groups from 12 months to 24 months by 0.49 days/week. Activity tracking frequency also decreased for both groups by 1.10 days/week. In comparison to their baseline values of 5 days/week for food tracking and 6 days/week for activity tracking frequency, both values were significantly lower at 24 months.

Habit Strength. Habit strength showed a statistically significant decrease from 12 to 24 months by a mean score of 0.44. However, it remained significantly higher than the baseline total score of 2.

Discussion

This paper reports the 24-month follow-up results of an intervention developed to increase and maintain weight loss in the National DPP. Both groups showed long-term weight loss of about 6.13% compared to baseline, even though some weight regain occurred post-intervention. No between group differences were found. Furthermore, both groups showed significant decreases in self-monitoring and habit strength from 12 to 24 months, but habit strength remained higher than at baseline. No significant changes were seen after the end of the intervention for diabetes risk factor variables of weight circumference and physical activity duration, steps, and equivalents, i.e. these positive changes remained.

Our results show that the long-term maintenance for our program was slightly better than the National DPP (7), with 62.07% versus 52.6% of participants maintaining 5% weight loss at 24-month follow-up. Although both interventions were delivered in the community, ours was delivered by highly trained clinical psychology PhD students who were well versed in CBT and other behavior intervention strategies compared to delivery by lay

coaches in the National DPP study. It is possible that the knowledge and experience in facilitating behavior change improved its effectiveness. Further research assessing these effects on National DPP efficacy is needed.

Conclusion

We found large reductions in weight from baseline to 3 and 12 months with a significant portion maintained at 24 months. Participants lost 9.98% of their initial body weight at 12-month follow-up and retained this weight loss at 6.13% of their initial weight at 24-month follow-up. Furthermore, a greater percentage of those who lost 5% of their initial weight at the end of intervention maintained this weight loss at 24-month follow-up than in the most comparable study assessing weight loss maintenance of the standard National DPP.

Abbreviations

CBT- Cognitive Behavioral Therapy

CHIP- Cardiovascular Health Improvement Program

DPP- Diabetes Prevention Program

MCAR- Missing Completely at Random

RCT- Randomized Controlled Trial

Declarations

Ethics Clearance

The study was conducted between 2014 and 2017 with approval by the Research Ethics and Compliance Board of the Faculty of Medicine Research and Graduate Studies Office at McGill University (Montreal, Canada), reference number IRB A00-M107–12B. Written informed consent was obtained from all participants before starting any study procedures.

Consent for Publication

Consent for publication by the trials participants is not applicable to this study.

Availability of Data and Materials

The study protocol, statistical analysis plan, analytic code, and de-identified data that underlie the results from this study will be available starting at 3 months after article publication to researchers who provide a methodologically sound proposal. Proposals should be directed to the corresponding author. Data will be available following the signing of a data access agreement at the Open Science Framework (https://osf.io/).

Funding

The study was funded by the Canadian Institutes for Health Research Major Operating Grant.

Competing Interests

All authors declare no competing interests.

Acknowledgements and Author Contributions

BK was involved in the study conceptualization, planning, and management, and the writing and editing of the manuscript. HS was involved in the manuscript writing and editing. KC, MF, EI, and ZX were involved in the study management, group facilitation, manuscript editing. MF was also involved in the data analysis along with GS. EI was also involved in the study conceptualization. IL was involved in the study conceptualization, data collection, and manuscript editing. AL was involved in the study conceptualization and manuscript editing. SG was involved in the study conceptualization, study management, and manuscript editing. The McGill CHIP Healthy Weight Program Investigators include Shannon Caron, Melodie Chamandy, Jenna Morris, Constanza Rosemary Lempereur de Saint Pierre, Julia Levy-Ndejuru, Virginia Rogers, Anna Saint-Martin, Michelle Sasson, and Anastasiya Voloshyn who contributed to the data collection and research assistance.

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Tables

Table 1. Mean changes in weight and secondary outcomes from 12 (post-intervention) to 24 months by group

	Standard National DPP (n = 59)					Enhanced National DPP (n = 51)					^{2}	p
	Mean (SE)	z	p	R^2	95% CI	Mean (SE)	z	p	R^2	95% CI		
Primary Outcome												
Weight (lbs)	5.58 (5.26)	1.06	.289	0.01	-4.74, 15.89	10.78 (5.94)	1.81	.070	0.03	-0.87, 22.43	0.43	.514
Diabetes Risk Factors												
Waist circumference (cm)	-0.24 (2.46)	-0.10	.923	0.00	-5.06, 4.59	1.00 (2.84)	0.35	.724	0.00	-4.57, 6.57	0.11	.742
Physical Activity												
Physical activity total duration (min/week)	42.62 (49.17)	0.87	.386	0.01	-53.75, 138.99	12.08 (97.05)	0.12	.901	0.00	-178.15, 202.31	0.07	.788
Physical activity pedometer steps (per day)	993.27 (93.00)	1.07	.286	0.02	-829.54, 2816.08	-1131.73 (59.76)	-1.89	.058	0.06	-2302.93, 394.70	3.21	.073
Physical activity step equivalents (per day)	1413.76 (158.14)	0.89	.371	0.01	-1685.78, 4513.30	-2210.32 (203.84)	-1.08	.278	0.02	-6205.51, 1784.87	1.16	.282
Self-Monitoring Index												
Food tracking frequency (days/week)	-0.61 (0.30)	-2.02	.044	0.02	-1.21, -0.02	-0.43 (0.22)	-1.90	.058	0.02	-0.86, 0.01	0.25	.620
Activity tracking frequency (days/week)	-1.26 (0.35)	-3.59	<.001	0.07	-1.95, -0.57	-0.95 (0.34)	-2.85	.004	0.05	-1.61, -0.30	0.40	.528
Behavior Change Index												
Average fat intake (grams/day)	3.54 (3.13)	1.13	.258	0.01	-2.59, 9.67	2.34 (3.58)	0.65	.513	0.01	-4.67, 9.35	0.06	.801
Average caloric intake (per day)	18.85 (72.90)	0.26	.796	0.00	-124.03, 161.73	-39.18 (80.68)	-0.49	.627	0.00	-197.43, 118.95	0.29	.593
Habit Strength Index												
Total score	-0.46 (0.25)	-1.86	.063	0.03	-0.94, 0.03	-0.42 (0.23)	-1.81	.070	0.03	-0.88, 0.03	0.01	.910

Table 2. Mean changes in weight and secondary outcomes from 12 (post-intervention) to 24 months pooled across groups

			Pooled Estimates (Change from 12 months to 24 months)					
	Mean at Baseline	Mean at post-intervention (12 months)	Mean Change (SE)	*z*	*p*	95% CI	R^2 – Standard National DPP	R^2 – Enhanced National DPP
Primary Outcome								
Weight (lbs)	204.03	183.67	7.85 (3.96)	1.98	.047	0.09, 15.61	0.02	0.02
Diabetes Risk Factors								
Waist circumference (cm)	108.79	101.25	0.32 (1.87)	0.17	.863	-3.34, 3.98	0.00	0.00
Physical Activity								
Physical activity total duration (min/week)	98.79	220.89	35.48 (45.37)	0.78	.434	-53.44, 124.40	0.01	0.00
Physical activity pedometer steps (per day)	7403.26	8740.25	-549.96 (55.22)	-0.10	.319	-1632.19, 532.26	0.01	0.02
Physical activity step equivalents (per day)	9058.36	13369.17	-1644.60 (165.78)	0.10	.921	-3413.70, 3084.77	0.00	0.00
Self-Monitoring Index								
Food tracking frequency (days/week)	4.43	0.84	-0.49 (0.18)	-2.68	.007	-0.85, -0.13	0.02	0.03
Activity tracking frequency (days/week)	6.30	1.48	-1.10 (0.24)	-4.53	<.001	-1.58, -0.62	0.06	0.06
Behavior Change Index								
Average fat intake (grams/day)	51.94	49.34	3.02 (2.36)	1.28	.201	-1.61, 7.64	0.01	0.01
Average caloric intake (per day)	1465.31	1434.85	-7.46 (54.31)	-0.14	.891	-113.90, 98.97	0.00	0.00
Habit Strength Index								
Total score	2.85	4.41	-0.44 (0.17)	-2.60	.009	-0.77, -0.11	0.03	0.03

Figures

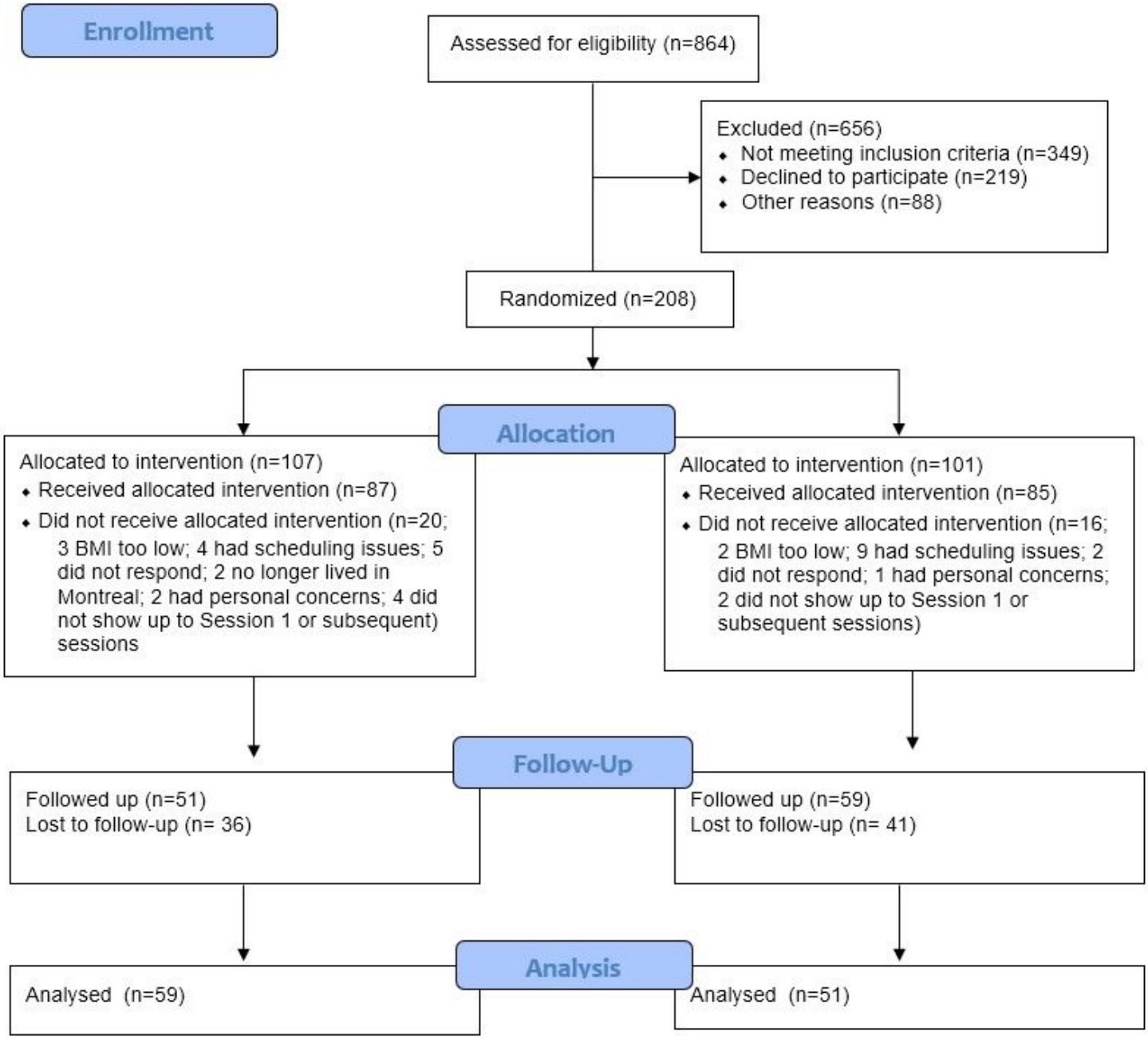

Figure 1

CONSORT flow diagram of the screening, group randomization, follow-up data and analysis

Supplementary Files

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