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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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 12.51lbs 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 DPP, a group-based shortened version, called the Group Lifestyle Balance (GLB) program, was developed (5). While less costly to implement and thus more accessible, its effectiveness is lower than the DPP. A recent meta-analysis showed that weight loss with the GLB was 3.99% at post-intervention compared to 7% with the DPP (6). One of the few GLB 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% (it is unclear why the results were reported as probabilities and not actual percentages of weight loss), but only 17.3% of participants maintained this weight loss one year post-intervention (7). 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 GLB, our study integrated habit formation techniques, specifically if-then plans, to reinforce habit change (8,9). This group was called the enriched

GLB or the McGill Comprehensive Health Improvement Program (CHIP) Healthy Weight Program as it was conducted with the McGill CHIP which is a multidisciplinary disease management and prevention program that is the primary site of academic research and teaching activities on exercise and health for the McGill medical community. 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). However, not many long-term studies of implementation intentions and complex behaviors yet exist.

The GLB standard and enriched versions were delivered over one year (12 weekly core sessions, 4 transitional sessions over 3 months, and 6 monthly support sessions). The 3- (end of core sessions) and 12- (end of intervention) months results of the if-then enhanced randomized controlled trial (RCT) have been published (11). No between-group differences were found, i.e. there appeared to be no added benefit to augmenting the GLB (control group) with the if-then plans (enriched GLB group). However, both groups displayed large weight losses of 9.98% over 12 months. One of the reasons hypothesized for the lack of significant group differences was that participants in both conditions were trained to become more aware of their internal and external cues and to create responses to these cues. As a consequence, the creation of if-then plans might have also occurred in the standard GLB group participants, just more implicitly. Also, the coaches in both groups were highly trained in cognitive behavioral therapy (CBT; 11) and spent two entire sessions teaching participants how to identify problematic cues and add positive food, physical activity, and social cues to their environment. It is possible that this behavioral training in addition to the therapeutic contact with the coaches that all participants received increased the overall effectiveness of the program but did not allow for much difference between the standard and enriched GLB groups.

This paper reports the findings of our RCT after a 1-year no-contact follow-up period or 24-months. 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 follow-up (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 GLB manual was adhered to in both groups (5) and if-then plans were integrated into sessions of the enriched 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 enriched GLB group and 59 in the standard GLB 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 were 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 a Missing Completely At Random (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 $\alpha = .05$ indicated no group difference in the estimate examined. Due to the non-significant model difference, average pooled change scores were computed across groups.

Results

Demographic information of participants at baseline and 24-month follow-up is presented in Table 1. Information about completed measures is reported in the protocol paper (12). Mean changes in all study outcomes from 12 to 24 months are reported in Table 2. Chi-square values indicate that mean changes for all variables did not differ between groups.

Primary Outcome

Table 3 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 ($p = .047$), with participants regaining on average 7.85lbs of the 20.36lbs that they had lost. However, participants were still 12.51lbs

(or 6.13%) lighter at 24 months than at baseline; they had lost 9.98% of their initial body weight at 12-month follow-up. More than half of all participants who achieved a clinically significant weight loss of 5% at post-intervention (62.07%) maintained this weight loss at 24 months.

Secondary Outcomes

Pooled results showed significant changes at 24-month follow-up only for self-monitoring and habit strength. All other variables showed no significant change from 12 to 24 months, i.e., all changes achieved at 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 of the GLB. Both groups showed long-term weight loss of about 6.13% compared to baseline, even though some weight regain occurred post-intervention. A weight loss of above 5% is considered to be clinically significant indicating an effective behavioral weight loss program (3). Specifically, a 5-7% decrease in body weight has been shown to be linked to a 58% decrease (compared to placebo) in the incidence of diabetes following participation in the DPP program (3). However, in this study, 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. positive changes accumulated in these variables at the end-of-intervention at 12 months remained at 24-months.

Pooled results over both conditions show that the long-term maintenance for our program was slightly better than the long-term maintenance in Piatt et al.'s study (7), which is the only study that provided long-term 24 months results of the standard GLB. That is, 62.07% of participants in our program versus 52.6% in Piatt et al.'s study maintained 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 GLB study In our study, it is possible that the knowledge and experience of the coaches in facilitating behavior change improved its effectiveness, as explained above, and, as such, the addition of explicit if-then planning was not a strong enough intervention to render stronger effects in the enriched GLB group

compared with the standard GLB group. Further research assessing the effects of delivery method and coaches on GLB efficacy is needed.

A few limitations of the current study should be mentioned. Our 24-months results are compared only with one other study, namely that of Piatt et al., (7). It is the only other currently available study that provides 24-months results of the GLB. Although a direct comparison must be made with caution, it is noteworthy that other behavioral weight loss program studies found that most people regain all of their weight by 6 to 12 months after completion of the lifestyle intervention and oftentimes even surpass their baseline weight (17). Thus, the results of both our study and that of Piatt et al. shine an optimistic light at the ability of the GLB to effect clinically significant long-term maintenance.

Another limitation is the attrition rate at follow-up, which was 46% in this study (107 to 51 participants in the enriched GLB group and 101 to 59 in the standard GLB group). However, the degree of attrition is typical for long-term follow ups (18) and our statistical methods used to impute the missing data compensate for possible systematic attrition (15,16).

The current study has implications for ways to achieve better long-term weight loss maintenance in group-based behavioral weight loss programs. Specifically, our study draws attention to the importance of training coaches to effectively teach behavior change techniques to participants. These techniques include if-then contingencies, which are an integral part of behavior planning and habit formation.

Conclusion

We found large reductions in weight from baseline to 3 and 12 months with a significant portion maintained at 24 months in the GLB program enriched with if-then plans. 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 baseline 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 GLB. As such, even though the addition of habit formation tools of if-then plans to the GLB protocol did not show a greater weight loss at one-year follow-up compared to baseline, the enhancement of the protocol with this tool did show a greater ability to allow for weight-loss maintenance than the standard GLB.

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/).

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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. Demographic information of participants at baseline at 24-month follow-up

	Initially enrolled (n = 172)	Completed 24-mon follow-up (n = 110)
Demographics		
Age, mean (*SD*) (years)	50.22 (11.97)	52.18 (11.65)
Gender, n (%) female	138 (80.23)	87 (79.09)
Caucasian, n (%)	135 (78.49)	90 (81.82)
Married, n (%)	99 (57.56)	65 (59.09)
Education, n (%) bachelor's degree	124 (72.09)	79 (71.82)
Employed, n (%)	132 (76.74)	84 (76.36)
Household Income, > $40,001, n (%)	117 (68.02)	75 (68.18)
Smoker, n (%)	9 (5.23)	3 (2.73)
Primary Outcome		
Baseline weight, mean (*SD*) (lb)	204.03 (31.79)	202.16 (29.96)

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

	Standard GLB (n = 59)					Enriched GLB (n = 51)					2	p
	Mean (SE)	z	p	R^2	95% CI	Mean (SE)	z	p	R^2	95% CI		
bs)	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
Risk												
rence	-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
otal ek)	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
er r	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
tep nts	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
ng												
king y ek)	-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
y ek)	-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
ndex												
fat ay)	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
take	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
ength												
re	-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

able 3. Mean changes in weight and secondary outcomes from 12 (post-intervention) to 24 onths pooled across groups

				Pooled Estimates (Change from 12 months to 24 months)					
	Mean at Baseline	Mean at post-intervention (12 months)	Mean at follow-up (24 months)	Mean Change (SE)	*z*	*p*	95% CI	R^2 – Standard National DPP	R^2 – Enhanced National DPP
y ne									
t (lbs)	204.03	183.67	191.52	7.85 (3.96)	1.98	.047*	0.09, 15.61	0.02	0.02
es Risk s									
ference	108.79	101.25	101.57	0.32 (1.87)	0.17	.863	-3.34, 3.98	0.00	0.00
al									
al total on eek)	98.79	220.89	256.37	35.48 (45.37)	0.78	.434	-53.44, 124.40	0.01	0.00
al eter per	7403.26	8740.25	8190.29	-549.96 (55.22)	-0.10	.319	-1632.19, 532.26	0.01	0.02
al step lents ay)	9058.36	13369.17	11724.57	-1644.60 (165.78)	0.10	.921	-3413.70, 3084.77	0.00	0.00
ring									
racking ncy week)	4.43	0.84	0.35	-0.49 (0.18)	-2.68	.007*	-0.85, -0.13	0.02	0.03
g ncy week)	6.30	1.48	0.38	-1.10 (0.24)	-4.53	<.001*	-1.58, -0.62	0.06	0.06
or e Index									
e fat s/day)	51.94	49.34	52.36	3.02 (2.36)	1.28	.201	-1.61, 7.64	0.01	0.01
e intake ay)	1465.31	1434.85	1427.39	-7.46 (54.31)	-0.14	.891	-113.90, 98.97	0.00	0.00
Strength									
core	2.85	4.41	3.97	-0.44 (0.17)	-2.60	.009*	-0.77, -0.11	0.03	0.03

**Significant at p<0.05*

Figures

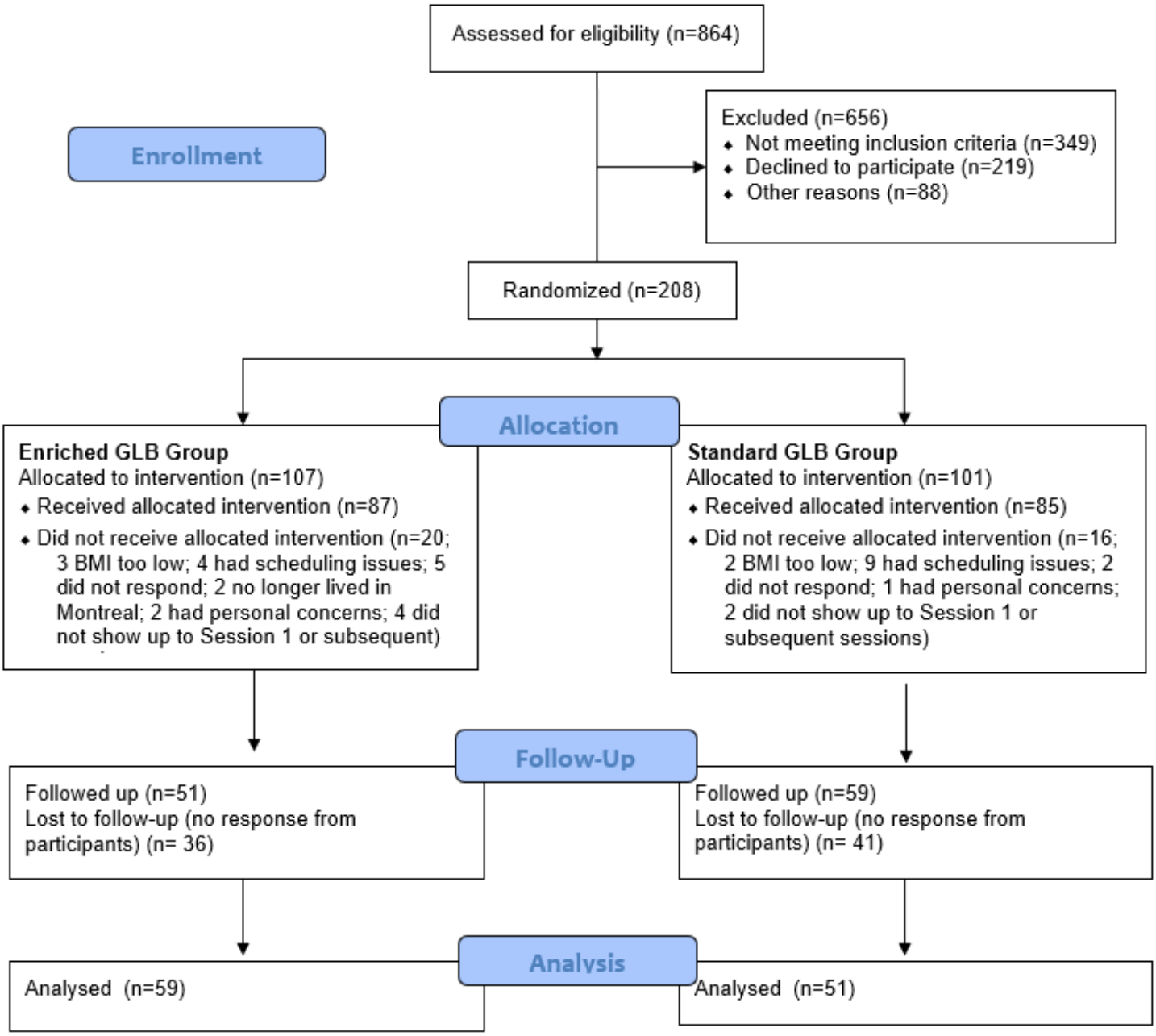

Figure 1

CONSORT flow diagram of the screening, group randomization, 24-month follow-up data, and analysis

Supplementary Files

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- TrialsSubmissionCONSORT2010Checklist.doc