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Behavioral mediators of weight loss in the SHED-IT community randomized controlled trial for overweight and obese men

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ABSTRACT

Background: Little is known about which behavioral strategies are most important to target in weight loss interventions for men. Purpose: To identify behavioral mediators of weight loss in the male-only SHED-IT community weight loss study. Methods: A randomized controlled trial with 159 overweight/obese men [mean (SD) age = 47.5(11.0) years; Body Mass Index = 32.7(3.5) kg/m²] assessed at baseline, three months (post-test) and six months (follow-up). Results: In an intention-to-treat, multiple-mediator model, the significant intervention effect on weight at 6 months (-3.70 kg; p<0.001) was mediated by increases in physical activity (steps/day) and decreases in take-away meals (kJ/day) and portion size at 3 months. The largest mediation effect was for physical activity (-0.6 kg; 95% confidence interval -1.4,-0.1). Overall, the targeted mediators accounted for 47.0% of the intervention's effect on weight. Conclusion: Step counts, takeaway food, and portion size may be key areas to target in future weight loss programs for men (ACTRN12610000699066).

Keywords: mediation, weight loss, male, obesity, intervention

Obesity is a chronic health condition with many physical and psychological co-morbidities ¹. Although behavioral interventions can effectively generate modest weight loss ², these programs may not necessarily work for men, who are significantly under-represented in weight loss research ³. This is concerning, as men generally store excess fat abdominally, which increases their risk of obesity-related illness ⁴. Further, while much research has investigated the efficacy of various weight loss approaches, less is known about which program components are most important, particularly in male-only samples ⁵.

Mediation analysis is an important statistical technique to identify possible mechanisms for success in behavioral interventions. In theory, a mediator variable is situated between an independent variable (e.g. treatment) and a dependent variable (i.e. study outcome) on a causal chain ⁶. While the best evidence to isolate causal effects of different weight loss strategies would be obtained by randomizing participants to interventions that focus on a single strategy (e.g. increasing daily steps), identifying substantive mediators of multi-component programs can provide useful information to inform future research and more targeted interventions, as important components can be emphasized and less important components removed. Although many studies have investigated mediation effects in physical activity and nutrition interventions (e.g. ^{7,8}), fewer have considered mediators of weight loss (e.g. ^{9,10}). Further, although sustainable behavior change is essential for success, most weight loss mediation studies have not examined behavioral mediators (e.g. ¹¹). As noted above, these studies generally include an over-representation of women ³ and often obscure sex-specific effects by statistically adjusting for sex instead of presenting results for men and women separately ⁴. As such, little evidence exists to illuminate which health behaviors are most important to target in weight loss programs specifically for men.

The SHED-IT community randomized controlled trial ^{12,13} investigated the effectiveness of two versions of a gender-tailored weight loss program for men (online self-

monitoring vs. paper-based self-monitoring), compared to a control. In addition to recruiting men only, the programs were designed to appeal specifically to men with a series of evidence-based, gender-tailored weight loss messages. At 3 months (post-test) and 6 months (follow-up), significant treatment effects were observed for weight in both the Online group and paper-based (Resources) group compared to the control¹³. The aim of the current study was to investigate which of the weight loss behaviors specifically targeted in the intervention also served as mediators of the intervention effect on weight at 6 months.

Methods

Participants

In August 2010, 159 men (18-65 years; Body Mass Index (BMI) 25-40 kg/m²) were recruited from Newcastle, Australia. All men passed an eligibility screener¹² and provided consent.

Design and Interventions

The SHED-IT community trial was an assessor-blinded randomized controlled trial that evaluated the effectiveness of two gender-tailored weight loss interventions for men. Extensive details on the methods¹² and results^{13,14} of this study can be found elsewhere. Briefly, men were randomized to one of the three study arms: (i) Resources (i.e. the SHED-IT Program with paper-based self-monitoring), (ii) Online (i.e. the SHED-IT Program with online self-monitoring), or (iii) no intervention for 6 months (wait-list control). The two programs differed only in terms of self-monitoring modality (i.e. online vs. paper-based) and e-feedback, with the Online group also receiving seven dietary and physical activity feedback emails. The study received institutional ethics approval and was registered with the Australia New Zealand Clinical Trials Registry (ACTRN12610000699066).

Both SHED-IT programs were theoretically-based and operationalized Bandura's Social Cognitive Theory, targeting key cognitions such as self-efficacy, self-regulation, perceived barriers, and social support. Men were provided with a weight loss resource

package, which consisted of: 1) a 25-minute DVD on weight loss for men; 2) the *Weight Loss Handbook for Blokes* and the *Weight Loss Support Book for Blokes*; 3) a pedometer, tape measure for waist circumference and a kilojoule (kJ) counter book. Rather than a strict dietary regime, men were taught the ‘mathematics of weight loss’ and advised to achieve a negative energy balance by setting a daily kJ intake target and implementing key dietary messages, which targeted specific behaviors of particular concern for Australian men (i.e. portion sizes, energy-dense nutrient-poor snacks, take-away foods (i.e. fast-foods) and sugar-sweetened beverages) ¹⁵. Of interest, other male-only weight loss programs internationally have also focused on these areas ¹⁶, which may indicate some global commonalities in men’s poor dietary habits. Importantly, men were not required to completely avoid all energy-dense foods and drinks (e.g. alcohol), but were encouraged to plan these extras into their daily kJ allowance. The SHED-IT program resources were ‘masculinized’ using anecdotes, statistics and strategies that men could relate to. This process was guided by formative work with overweight and obese men ¹⁵, and the men’s health literature ¹².

Sample size

The primary study ¹³ was designed to detect a between-group difference of 4 kg (SD 5 kg) at 6 months. Thus, for 80% power ($p = 0.015$, two-sided) a sample of 150 men was required to allow for a predicted attrition rate of 28%. This sample size also powered the current analysis to detect medium-to-large effects with the bias-corrected bootstrap procedure ¹⁷.

Assessments

Measures were obtained from all men at baseline and follow up data were collected from 82% of the sample at 3 months (post-test) and 81% at 6 months (follow-up), with no significant difference in retention between groups. Measures were taken by trained, blinded research assistants who adhered to standardized procedures. The primary outcome was weight (kg), measured to 0.01 kg on a digital scale (CH-150kp, A&D Mercury Pty Ltd,

Australia). A participant flowchart for this trial is provided elsewhere ¹³.

All hypothesized behavioral mediators of the treatment effect on weight were assessed with validated measures ¹². *Physical activity* was objectively measured for seven consecutive days using Yamax SW-200 pedometers, which are reliable and valid (Yamax Corporation, Kumamoto City, Japan). *Sitting time* was assessed using the Sitting Questionnaire, which has been shown to be both a valid and reliable measure of sedentary time ¹⁸. Energy from *sugar-sweetened drinks, kJ-dense snacks and take-away meals* were assessed with the Australian Eating Survey, which is a validated, semi-quantitative food frequency questionnaire ¹⁹. Portion size was assessed with a validated subscale from the Dietary Questionnaire for Epidemiological Studies Version 2 ²⁰. The time referent for the mediator measures matched the time difference between assessments (i.e. the previous 3 months) with the exception of step count data, which were collected in the week prior to baseline assessments and the week after post-test and follow-up assessments. Importantly, each mediator was targeted during the intervention and was represented as a key weight loss message for men. Additional detail on mediator measures is available elsewhere ¹².

Statistical analyses

In the randomized controlled trial, significantly intervention effects were observed at 6 months. Compared to the control, the *Online* group lost an additional 4.2 kg (95% CI 2.5, 5.9) and *Resources* group lost an additional 3.2 kg (95% CI 1.5, 4.9). However, the difference between intervention groups was not significant ($p > 0.05$). Therefore, to maximize power, both intervention groups were combined and compared to the control in the current analyses.

The mediation analyses were conducted in SPSS Statistics Version 21 (SPSS Inc, Chicago, Illinois, USA) using the INDIRECT Macro ²¹. This macro was used to: i) calculate the regression coefficients for the effect of the intervention on the hypothesized mediators (Pathway A), ii) examine the association between the mediator variable at 3 months and the

outcome variable at 6-months, independent of group assignment (Pathway B), and iii) estimate the total (Pathway C), direct (Pathway C') and indirect (Pathway AB) intervention effects. All analyses were adjusted for baseline values. This approach is preferred to using change score variables, which are affected by regression to the mean²². The macro also generated bias-corrected bootstrapped 95% asymmetrical confidence intervals around the indirect effect²¹. Significant mediation was established if these confidence intervals did not include zero. Finally, the proportion of the intervention effect attributed to each mediator was calculated by dividing the indirect effect (Pathway AB) by the total effect (Pathway C' + Pathway AB).

As recommended in the literature²³, an appropriate temporal sequence was employed to strengthen the evidence for mediation in the current analysis, which investigated whether weight loss at follow-up (6 months) was mediated by post-treatment scores for each hypothesized behavioral mediator at 3 months (Electronic Supplementary Material (ESM) Supplementary Figure S1). To adjust for pre-treatment effects, baseline values for weight and all mediator variables were included as covariates in the model. The multiple-mediator model followed an intention-to-treat approach, where missing data were imputed using the expectation maximization procedure in SPSS. This was deemed appropriate as Little's test did not reject the assumption that the data were missing completely at random ($\chi^2 = 161.6$, $df = 144$, $p = 0.15$). The amount of missing data for each variable was: weight (baseline: 0%; 6 months: 19%), step counts (baseline: 10%; 3 months: 27%), sitting time (baseline: 1%, 3 months: 18%), portion size, sweetened drinks, kJ-dense snacks, and takeaway food (baseline: 0%; 3 months: 18%). As noted above, the majority of missing data was due to drop-out at 3 months (18%) and 6 months (19%). For sensitivity purposes, a multiple-mediator model was also conducted with the completer's sample. As the INDIRECT macro only includes participants with complete data for every variable, the completers sample included 68% of

the participants and the intention-to-treat analyses included 100%. Finally, simple mediation models were conducted for each mediator (ESM Table S1). While not discussed here, these results will allow for comparisons with previous research and for the inclusion of single mediators in future meta-analyses, as recommended in the literature ²³.

Results

Details of the study sample are provided elsewhere ¹³. Briefly, the mean (SD) weight of the study sample was 103.4 (14.0) kg and the mean (SD) age was 47.5 (11.0) years. The majority of the sample was born in Australia (91%) and had a waist circumference greater than 102 cm (91%). Table 1 presents summary data for weight and each mediator during the trial. The total effect of the intervention on weight at 6 months was significant ($p < 0.001$) in both the intention-to-treat (-3.70 kg) and completers (-4.56 kg) analyses.

After controlling for baseline values, significant intervention effects were observed at 3 months for physical activity ($A = +1726$ steps/day, $p < 0.001$), takeaway food ($A = -201$ kJ/day, $p < 0.01$), portion size (-0.11 units, $p < 0.001$) and kJ-dense snacks (-512 kJ/day, $p < 0.001$) (Table 2). The intervention did not significantly influence sitting time ($p = 0.65$), but a marginal effect was observed for sweetened drink intake ($p = 0.06$). The completers-only, sensitivity analysis reflected the same pattern of significant effects. In addition, significant associations were observed between weight and physical activity ($B = -0.0004$, $p = 0.01$), kJs from takeaway food ($B = 0.0028$, $p < 0.001$), and portion size ($B = 5.0212$, $p < 0.01$), with the completers model only identifying an association between weight and energy from takeaway meals ($p < 0.001$).

As seen in Table 2, the multiple mediator model identified that 47% of the total intervention effect on weight at follow-up (6 months) could be attributed to changes in the hypothesized mediators during the intervention (Combined $AB = -1.74$ kg; 95%CI -2.78, -0.81). The largest mediated effect was observed through increases in physical activity, which

explained 16.5% of the intervention effect on weight ($AB = -0.61$ kg; 95%CI -1.37, -0.08). Significant mediated effects were also observed for kJ from takeaway food (15.4%; $AB = -0.57$, -1.49, -0.16) and portion size (14.3%; $AB = -0.53$ kg; 95%CI -1.11, -0.12). Although each variable mediated a similar proportion of the intervention effect on weight in both the intention-to-treat and completers-only populations, mediation was only established for physical activity and takeaway food intake in the completers-only, sensitivity analysis.

Discussion

The aim of this study was to investigate whether any of the specifically-targeted behavioral strategies in the SHED-IT Weight Loss Program for men significantly mediated the intervention effect on weight at follow-up. At 6 months, the SHED-IT intervention had a significant total effect on weight (-3.70 kg; $p < 0.001$). Of the included variables, increased physical activity (steps) represented the largest mediation effect. Mediation was also established for reduced portion size, and reduced kJs from take-away meals. Overall, the targeted mediators accounted for 47% of the total intervention effect on weight.

To date, men have been greatly under-represented in weight loss research³ and male-only weight loss studies are limited in quality and quantity⁵. As such, relatively little is known about successful strategies to enhance weight loss in men. In line with recent behavioral mediation analyses of the male-only 'Healthy Dads, Healthy Kids' trial⁹ and female-only '40-Something' trial²⁴, increasing men's daily step counts mediated the largest proportion of the SHED-IT Program's effect on weight. Strong evidence from randomized trials shows that physical activity has a unique and clinically important influence on weight loss²⁵. However, as these studies often examine the impact of physical activity via closely supervised exercise programs²⁵, the current results provide novel and important findings as the SHED-IT Program involved no face-to-face contact. Of interest, a process evaluation of SHED-IT revealed that the majority of the physical activity goals men set related to

increasing walking, rather than other higher-intensity exercises²⁶. Although increasing moderate-to-vigorous physical activity is a strongly supported weight loss strategy², these results provide good evidence for the role of targeting improvements in incidental physical activity during weight loss. In the SHED-IT Program, men were encouraged to increase their incidental activity and provided with a pedometer to self-monitor their step counts and encouraged to set goals and graph their weekly step average²⁶. Given the important mediation effect established for steps in the current study, future weight loss programs for men may benefit by including these self-monitoring strategies.

In addition to the physical activity effects, this study revealed that intervention effects on kJs from take-away meals mediated 15% of the SHED-IT interventions effect on weight at follow-up. While the benefit of diet plus physical activity interventions compared to physical activity interventions is well established²⁵, these results are novel given that, to the authors' knowledge, no studies have specifically isolated the influence of fast-food consumption on weight loss. In a systematic review examining the association between fast food access and obesity, White²⁷ noted that longitudinal, experimental data are urgently required to provide insight into the causal influence of this obesogenic factor. Of interest, Coughlin et al. recently identified that reducing take-away food consumption significantly mediated long-term weight loss maintenance in a sample of 1032 overweight/obese men and women²⁸. In contrast, results from the recent female-only '40-something' weight control study²⁴ indicated that the intervention effect on 'meals eaten outside of the home' was not a significant mediator of the treatment effect. Although this may indicate a potential sex difference in the importance of targeting take-away/fast food consumption during weight loss, this hypothesis requires further validation in future research. Of note, the SHED-IT Program was also successfully tested in a pilot study with the associated mediation analysis finding no significant mediation effects for any dietary variables²⁹, in contrast to the current study. However, the pilot did not

include a true control and the effect of the minimal intervention may have confounded the results. Further, the current SHED-IT program was improved with additional components and extensive theoretical- and gender-tailoring¹².

The current results suggest that targeting portion size may be an effective strategy in future weight loss studies for men. In the multiple-mediator model, intervention effects on portion size in the first three months mediated 14% of the weight loss effect at follow-up. Portion size was also noted as a significant mediator of long-term weight loss maintenance in a mediation analysis from a recent study²⁸. This is a noteworthy finding, given that a recent systematic review identified no randomized controlled trials specifically examining the role of portion size in weight loss³⁰. The authors also recommended that portion size intervention studies are urgently required to determine which types of strategies work for various target groups³⁰. In the context of the current findings, studies examining the utility of targeting portion size for weight loss certainly appear warranted, particularly in men.

Despite the intervention effect on sugar-sweetened drinks approaching significance, changes in this variable did not mediate the intervention's effect on weight at follow-up. However, it is important to note that floor effects in this mediator may have affected the results, with great variation observed at baseline between men in the lowest consumption quartile (0 – 51 kJ/day) compared to men in the highest quartile (657 – 4445 kJ/day). While beyond the scope and power-limitations of the current study, future research could investigate whether pre-treatment sugar sweetened beverage consumption acts as a moderator of this mediation effect. Similarly, although reducing sedentary time was specifically targeted during the intervention, participants did not significantly reduce sitting time compared to the control group. As such, more research is required to identify effective ways to target this variable.

This study contained several strengths including use of data from a methodologically-rigorous randomized controlled trial with a true control and validated measures, a multiple-

mediator, intention-to-treat analysis with adjustment for baseline values, high retention, blinded assessors, and objectively measured weight and physical activity. By examining the effect of mediators at post-test on weight loss at follow-up, this analysis also included appropriate temporal sequencing, which is an essential, but often overlooked, criteria to establish mediation ⁶. The study also had some limitations. As the study did not include measures to capture three SHED-IT weight loss messages (read food labels, keep a healthy lifestyle diary, and surf the urge (i.e. resisting unnecessary snacking)) ¹³, the importance of these tips could not be established. In addition, although the dietary mediators were measured with a validated questionnaire ¹⁹, they may have included more measurement error than the physical activity mediator, which was measured objectively. As such the model may have implicitly favored physical activity.

In conclusion, this study provides important evidence to inform the design of future weight loss programs for men. Intervention effects on reducing portion sizes, increasing daily step counts and reducing intake of take-away/fast food in the first three months accounted for just under half of the intervention effect on weight at follow-up. These findings have important implications for future research and practice. Initially, the current findings could be tested in replication studies with men from varied cultures. Future research could also investigate moderated-mediation effects, given that indirect effects may vary according to different levels of an additional variable (e.g. baseline BMI category). The inclusion of other variables (e.g. fruit and vegetable intake, resistance training) may strengthen the mediation effect in future trials. Finally, given that the strongest causal evidence is generated through randomization, future studies could consider randomizing men to interventions targeting each mediator in isolation. In a practical sense, this study presents good evidence that male-only weight loss studies may benefit by including an explicit focus on increasing men's daily step counts, and reducing portion sizes and consumption of take-away/fast food.

Mediators of weight loss in overweight men

Table 1

Participants' values for weight (baseline and follow-up [6 months]) and hypothesized mediators (baseline and post-test [3 months]).

Model outcome	Analysis	SHED-IT		Control	
		Baseline	6-month	Baseline	6-month
		Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
Weight (kg)	Intention-to-treat ^a	103.2 (13.5)	98.4 (14.6)	103.8 (15.0)	102.9 (14.8)
	Completers ^b	103.3 (14.1)	98.0 (15.6)	102.4 (13.2)	101.9 (13.2)
Hypothesized mediator [SHED-IT tip]	Analysis	SHED-IT		Control	
		Baseline	3-month	Baseline	3-month
		Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
Physical activity (steps/day) [Every step counts]	Intention-to-treat	6951.0 (2830.9)	9312.1 (3043.7)	6776.3 (2712.5)	7334.7 (2675.8)
	Completers	7207.1 (2760.2)	9573.3 (3414.2)	7133.5 (2745.2)	7360.3 (2913.0)
Sitting time (minutes/day) ^c [Reduce your sitting time]	Intention-to-treat	492.7 (199.3)	456.0 (192.7)	551.2 (196.1)	503.3 (211.7)
	Completers	499.6 (208.5)	459.0 (209.6)	538.8 (211.5)	514.5 (238.8)
Portion size (portion size factor) ^d [Reduce portion sizes]	Intention-to-treat	1.2 (0.3)	1.1 (0.3)	1.2 (0.3)	1.1 (0.2)
	Completers	1.1 (0.3)	1.0 (0.3)	1.1 (0.3)	1.2 (0.2)
kJ-dense snacks (kJ/day) [Reduce kJ-dense snacks]	Intention-to-treat	1746.6 (1406.2)	894.9 (675.7)	1626.5 (1117.5)	1355.8 (1177.4)
	Completers	1766.6 (1478.6)	844.3 (704.0)	1720.4 (1250.0)	1504.3 (1339.3)
Sugar-sweetened drinks (kJ/day) [Don't drink your kJs]	Intention-to-treat	518.8 (798.7)	350.9 (475.7)	492.9 (590.0)	449.1 (595.1)
	Completers	425.4 (562.3)	305.2 (432.0)	485.0 (596.0)	485.7 (666.2)
Take-away food (kJ/day) [Be prepared]	Intention-to-treat	1093.5 (654.1)	756.0 (617.7)	1123.1 (830.7)	1005.7 (778.0)
	Completers	1025.7 (554.9)	732.9 (668.6)	1101.9 (843.3)	1033.2 (803.6)

^a Intention-to-treat sample using all randomized participants (expectation maximization technique used to impute missing data) (n = 159 [107 intervention, 52 control]). ^b Completers = completers sample from multiple mediator model (i.e. complete outcome data for all mediators in model required) (n = 108 [70 intervention, 38 control]). ^c Non-work day sitting time. ^d Participants were shown a set of three portion size photographs of varying serving size for a number of foods. By indicating whether they ate less than, equivalent to, between, or more than the serving sizes shown, seven serving size options were available for each food. Using portion size distribution data from 810 adults, the first photo represented the 25th percentile, the second photo represented the median, and the third photo represented the 75th percentile. Participant responses to the foods were then averaged to create a portion size factor indicating whether on average a person ate median size serves (= 1), more than the median (> 1), or less than the median (< 1) for main meals.

Mediators of weight loss in overweight men

Table 2

Results of the multiple mediator model examining effect of the intervention on the potential mediators at post-test (3 months), and the association between changes in mediators at post-test and changes in weight at follow-up (6 months).

Hypothesized Mediator ^a	Analysis ^b	C' (SE) ^c	A (SE) ^d	B (SE) ^e	AB (SE) [95% CI] ^f	AB [mediated effect] (C'+ AB) [total effect] ^g
Physical activity (steps/day)	Intention-to-treat	-	1725.6 (391.0)***	-0.0004 (0.0001)*	-0.6 (0.3) [-1.4, -0.1]	16.5%
	Completers	-	2130.3 (545.3)***	-0.0003 (0.0002)	-0.7 (0.4) [-1.9, -0.1]	15.3%
Takeaway food (kJ/day)	Intention-to-treat	-	-200.8 (71.1)**	0.0028 (0.0008)***	-0.6 (0.3) [-1.5, -0.2]	15.4%
	Completers	-	-216.4 (97.8)*	0.0031 (0.0010)**	-0.7 (0.5) [-1.9, -0.1]	14.9%
Portion size ^h (portion size factor)	Intention-to-treat	-	-0.1 (0.0)***	5.0212 (1.8445)**	-0.5 (0.3) [-1.1, -0.1]	14.3%
	Completers	-	-0.2 (0.0)***	3.8201 (2.4611)	-0.6 (0.5) [-1.7, 0.2]	13.6%
Sitting time (minutes/day) ⁱ	Intention-to-treat	-	-13.3 (29.3)	0.0026 (0.0018)	-0.0 (0.1) [-0.3, 0.1]	1.1%
	Completers	-	-32.6 (39.0)	0.0034 (0.0023)	-0.1 (0.2) [-0.7, 0.1]	2.4%
kJ-dense snacks (kJ/day)	Intention-to-treat	-	-512.3 (117.1)***	0.0000 (0.0005)	-0.0 (0.3) [-0.6, 0.7]	0.3%
	Completers	-	-651.8 (161.6)***	-0.0002 (0.0006)	0.1 (0.5) [-0.8, 1.1]	-3.1%
Sweetened drinks (kJ/day)	Intention-to-treat	-	-122.9 (64.9)	-0.0001 (0.0008)	0.0 (0.2) [-0.3, 0.3]	-0.5%
	Completers	-	-145.9 (81.5)	-0.0005 (0.0011)	0.1 (0.2) [-0.3, 0.6]	-1.5%
Total effects	Intention-to-treat	-2.0 (0.7)**	-	-	-1.7 (0.5) [-2.8, -0.8]	47.0%
	Completers	-2.7 (1.1)*	-	-	-1.9 (0.8) [-3.4, -0.4]	41.8%

* p < 0.05; ** p < 0.01; *** p < 0.001; bold denotes significant effect

SE, standard error; CI, confidence interval; kJ, kilojoule; ITT, intention-to-treat (expectation maximization imputation)

^a Mediators presented in relation to magnitude of unique mediated effect on weight (largest to smallest; intention-to-treat analysis). ^b Completers sample from multiple mediator model (i.e. complete outcome data for all mediators in model required) (n = 108 [70 intervention, 38 control]); Intention-to-treat sample used all randomized participants (expectation maximization technique used to impute missing data) (n = 159 [107 intervention, 52 control]). ^c C' = Direct effect of the intervention on weight. ^d A = Intervention effect on mediators. ^e B = Association between mediators and weight. ^f AB = Indirect or 'mediated' effect (product of coefficients estimate). ^g Unique proportion of intervention effect on weight that was mediated (calculated from non-rounded results). ^h Participants were shown a set of three portion size photographs of varying serving size for a number of foods. By indicating whether they ate less than, equivalent to, between, or more than the serving sizes shown, seven serving size options were available for each food. Using portion size distribution data from 810 adults, the first photo represented the 25th percentile, the second photo represented the median, and the third photo represented the 75th percentile. Participant responses to the foods were then averaged to create a portion size factor indicating whether on average a person ate median size serves (=1), more than the median (> 1), or less than the median (< 1) for main meals. ⁱ Non-work-day sitting time.

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