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SHORT COMMUNICATION

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Characterising individual variability in associations between self-monitoring and weight change during and after a behavioral weight management program

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Abstract

Objective: Greater self-monitoring of caloric intake and weight has been associated with success at both initial weight loss and long-term maintenance. Given the existence of wide variability in weight loss outcomes and the key role of self-monitoring within behavioral weight management interventions, this study examined individual variability in associations between self-monitoring and weight change and whether demographic factors could predict who may best benefit from self-monitoring.

Methods: Participants were 72 adults with overweight or obesity (mean ± SD, age = 50.6 ± 10.3; body mass index = 31.2 ± 4.5 kg/m^2; 71%Female; 83%White) enrolled in a 12-week weight loss program followed by a 40-week observational maintenance period. Participants were encouraged to self-monitor caloric intake and weight daily and to report these data via a study website each week. Multilevel mixed models were used to estimate week-to-week associations between self-monitoring and weight change, by individual and linear regressions and ANOVAs were used to explore demographic differences in these associations.

Results: Most participants (68%) demonstrated statistically significant negative associations between self-monitoring of either caloric intake or weight and weight change. Of these, 76% benefited from self-monitoring both caloric intake and weight, 18% from self-monitoring caloric intake only, and 6% from self-weighing only. The magnitude of associations between self-monitoring and weight change did not significantly differ by age, gender, race/ethnicity, education, or income, all *p*s > 0.05.

Conclusions: Differences in the effectiveness of self-monitoring for weight loss were not observed by demographic characteristics. Future research should examine if other factors may predict the effectiveness of self-monitoring.

KEYWORDS

behavior therapy, clinical practice, obesity, self-monitoring

1 | INTRODUCTION

Behavioral weight loss interventions remain the first-line of treatment for adult obesity, and typically produce average weight losses of 5%–10% of initial body weight.[1] There is substantial individual variability in treatment outcomes,[2] however, suggesting that these programs are not equally effective for all participants. For example, the standard deviations around mean weight losses during initial weight loss programs are often as large as the means themselves, and this variability often increases during post-intervention maintenance periods.[2]

Although differences in adherence to intervention goals explain some of this variability,[2] it may also be possible that certain intervention strategies are more effective for some individuals than others. For example, self-monitoring of dietary intake, physical activity, and weight has been described as a 'cornerstone' of behavioral weight loss treatment.[3,4] Self-regulation theory posits that self-monitoring encourages goal attainment by providing participants with feedback on progress toward their goals, serving as reinforcement when goals are met and highlighting areas for change when goals are not met.[5] Greater adherence to self-monitoring has been demonstrated to be associated with greater initial weight loss[6] and long-term weight loss maintenance[7,8]; however, less is known regarding whether self-monitoring is differentially effective for weight loss for certain individuals.

Two studies provide evidence that some groups of individuals may perceive self-monitoring as more or less effective for weight management. In a survey of general internal medicine clinic patients with obesity, Blixen and colleagues[9] found that African American women rated self-monitoring of dietary intake as significantly less important for weight loss success compared to White women. Looking at weight loss maintenance, Kinsey and colleagues[10] asked former participants of behavioral weight management programs to rank facilitators and barriers to maintenance and found that, among successful weight loss maintainers, White participants ranked self-monitoring of weight and caloric intake as equal (both tied for rank 2) whereas African American participants ranked self-monitoring of caloric intake higher in the list of facilitators compared to self-monitoring of weight (rank 4 vs. 7, respectively).

Despite differences in the perceived effectiveness of self-monitoring,[9,10] few studies have examined differences in the associations between self-monitoring and weight change by demographic characteristics. One recent study examined the relative contribution of various treatment components within Look AHEAD's intensive lifestyle intervention to weight loss within racial/ethnic and sex subgroups[11] and found no statistically significant differences between groups in associations between self-reported adherence to daily self-weighing (captured via a 28-item checklist administered at major assessment points) and weight loss at 1, 4, or 8 years after intervention enrollment. No studies, however, have examined the impact of self-monitoring of both caloric intake and weight, and no studies have examined these associations at the within-individual level, for example, using more proximally reported self-monitoring data.

Thus, the current study aimed to characterize individual variability in the week-to-week associations between self-monitoring of caloric intake, self-weighing, and weight change in adults taking part in a 12-week behavioral weight loss program followed by a 40-week maintenance period in which no additional intervention was provided. Following a description of individual variability in associations between self-monitoring and weight change within the sample, exploratory analyses were conducted to evaluate whether self-monitoring of caloric intake and weight were differentially effective for weight loss by demographic characteristics, including age, gender, race/ethnicity, education, and income.

2 | METHODS

The current study was a secondary analysis of data from a 12-week, Internet-based behavioral weight loss intervention followed by a 40-week observational maintenance period in which no additional intervention was provided. Details regarding parent study recruitment, inclusion and exclusion criteria, and baseline participant characteristics have been published previously.[12] Briefly, results from the parent study demonstrated that participants with overweight or obesity enrolled in an Internet-based behavioral weight loss program lost an average (mean ± SE) of −5.78 ± 0.60 kg (6.37 ± 0.60% of their baseline weight) during the 12-week intervention.[12]

2.1 | Participants

Participants in the parent study were adult (age 18–70) employees (or dependents of employees) of a healthcare organization in Providence, Rhode Island who had a body mass index > 25 kg/m^2 and access to an internet-connected computer at home. Potential participants were excluded from the parent study if they weighed over 150 kg (due to study scale limits), had any health conditions contraindicating weight loss, were pregnant or planned to become pregnant, had a history of bariatric surgery, or were enrolled in another weight management program. The current study included participants in the parent study who reported self-monitoring data for caloric intake and weight for at least 2 weeks. Moreover, participants in the parent study were excluded from current analyses if they exhibited no variability in their adherence to self-monitoring (e.g., reporting seven out of 7 days of self-monitoring for every week that they self-monitored), as this precluded ability to assess within-individual associations between self-monitoring and weight change.

2.2 | Initial intervention and maintenance period

Participants in the parent study were provided with a 12-week, Internet-based behavioral weight loss program modeled after the lifestyle intervention of the Diabetes Prevention Program[13] that had

been previously implemented in community[14] and primary care[15] settings. The intervention period of the parent study began with an hour long in-person group session at which participants were provided with information about the study website, basic education about weight management, and given calorie, dietary fat, and physical activity goals that were designed to produce weight losses of 1–2 lbs per week.[13] Caloric intake goals ranged between 1200 and 1800 kcals per day (based on baseline weight), with less than 30% of kcal intake from fat (set as a goal in grams). Participants were instructed to gradually increase their engagement in moderate-intensity physical activity (e.g., brisk walking), eventually reaching a goal of 200 min per week. Participants also learned how to use study-provided self-monitoring tools (a calorie reference book, paper self-monitoring records, and a body weight scale) and were encouraged to use these tools to self-monitor caloric and fat intake (writing down all foods/drinks consumed along with the kcal and grams of fat for each food/drink), weight, and physical activity daily throughout the intervention. Throughout the initial 12-week Internet-based weight loss intervention, online lessons were released to participants each Monday. Participants were asked to log into the study website by Sunday at midnight each week to report their weight, calorie and fat intake (only total kcal and grams, respectively; participants were not asked to report the actual foods/drinks consumed each day), and minutes of physical activity for each day that previous week, and to answer an 11-item questionnaire focused on cognitions, mood, and behaviors hypothesized to be associated with weight loss and maintenance.[12,16] At the next log-in (starting the following Monday morning), participants were provided with automated feedback messages tailored to their self-reported self-monitoring data.

The initial 12-week intervention period was followed by a 40-week observational maintenance period during which no additional intervention was provided (there were no new lessons posted, participants could no longer access older lessons via the study website, and no automated feedback was provided based on self-monitoring data). Throughout the maintenance period, participants were asked to continue to self-monitor their dietary intake, weight, and physical activity daily. Participants were also asked to continue to log into the study website once each week to self-report self-monitoring behaviors and to answer the 11-item questionnaire; however, rather than entering daily values for caloric intake, fat intake, weight, and minutes of physical activity, participants were asked to report the number of days they self-monitored their weight, dietary intake, and total minutes of physical activity achieved that week. No minimum value for caloric intake or fat intake was given to participants to define that a day of self-monitoring had occurred.

2.3 | Measures

Demographic characteristics (i.e., age, gender, race/ethnicity, education level, and annual household income) were assessed via a self-report questionnaire at baseline. Body weight was collected to the 0.1 kg using a study-provided e-scale which used the cellular network to transmit weights directly to a research server[17] and has been demonstrated to have high concordance with assessment weights measured in-person.[18] Of note, these scales were used only for data collection purposes; data from these scales did not sync with the study website and participants did not have access to view historical weight data; they could only see their weight displayed on the scale each day. Participants were encouraged to weigh themselves daily, first thing in the morning after voiding but before having anything to eat or drink.

Self-monitoring adherence throughout the initial intervention was defined as the number of days each week that participants self-monitored caloric intake and weight. For weeks 1–12 (during the initial intervention), the total number of days each week that caloric intake and weight were entered via the study website were summed to create a count variable. As no minimum threshold for caloric intake was given to participants for self-reporting self-monitoring adherence during the maintenance program, no minimum value for caloric intake was used when assessing a day of self-monitoring during the initial intervention period (a day where any positive, non-zero number of calories were reported was coded as a day of self-monitoring caloric intake). During the maintenance period, participants reported a count of the number of days each week that they self-monitored caloric intake and weight each week; thus, this self-reported count variable was used for weeks 13–52. Participants were only asked to report the total number of minutes of physical activity each week during the maintenance period, not the days that physical activity was self-monitored; therefore, associations between self-monitoring of physical activity and weight change were not examined.

2.4 | Statistical analysis

Analyses were conducted in SAS version 9.4 and R Studio version 4.1.1. As part of a previous study, LOESS regression models were used to estimate the slopes of weight change each week from daily e-scale data,[16] such that positive values indicated weight gain and negative values indicated weight loss from a given Monday through the following Sunday. In the current analyses, multilevel mixed models were used to estimate associations between the number of days self-monitoring caloric intake or weight and weight change by individual. These estimates were saved and used to characterize associations between days of self-monitoring and weight change for each participant. Participants were categorised as having a significant association in the expected direction between self-monitoring and weight change if they demonstrated a statistically significant (e.g., $p < 0.05$) negative association between self-monitoring and weight change. Similarly, participants were categorized as having a significant association in the unexpected direction if they demonstrated a statistically significant (e.g., $p < 0.05$) positive association between self-monitoring and weight change, and as having no association if the association between self-monitoring and weight change was not statistically significant (e.g., $p > 0.05$). Linear regressions were used to

examine the magnitude of associations between days of self-monitoring and weight change by age, and one-way ANOVAs were used to examine the differences in the magnitude of associations between self-monitoring and weight change by gender, race/ethnicity, education, and income.

3 | RESULTS

Of the 75 participants included in the parent study, one participant was excluded from the analytic sample for missing self-monitoring data (this person never used the scale and never logged into the study website), and two participants were excluded due to lack of variability in self-monitoring data (i.e., recording seven out of 7 days for each week that self-monitoring was reported). Thus, the current analytic sample included 72 adults (see Table 1 for demographic characteristics).

On average, throughout the full study year, participants self-monitored their caloric intake and weight an average (mean ± SD) of 3.2 ± 1.7 and 4.3 ± 1.8 days each week, respectively. Across the initial 12-week intervention, the average number of calories self-reported per day by participants was 1389.2 ± 413.2 kcals (range = 0–14,443 kcals); although higher values are likely to be typos, in the current study, we only coded adherence as 0/1 and did not use actual caloric values, therefore these outliers were not removed. Participants self-monitored on more days each week during the initial intervention compared to the maintenance period (caloric intake = 6.0 ± 1.5 vs. 2.4 ± 2.0 days/week, respectively, t (71) = 14.56, $p < 0.001$; weight = 6.0 ± 1.5 versus 3.8 ± 2.1 days/week, t (71) = 10.63, $p < 0.001$). Overall, participants lost an average of −5.8 ± 4.9 kg (−6.43 ± 4.7%) during the initial intervention and regained an average of 2.4 ± 3.7 kg (3.0 ± 4.6%) during the maintenance period, reflecting an overall weight change of −3.8 ± 6.3 kg (−3.6 ± 6.8%) during the full study year.

Across all participants, each additional day of self-monitoring caloric intake within a given week was associated with an average −0.05 ± 0.05 kg greater weight loss during the same week. Forty-seven participants (65%) demonstrated statistically significant associations between the number of days of self-monitoring caloric intake and weight change. Of these, 46 (98%) demonstrated statistically significant associations in the expected direction, such that greater adherence to self-monitoring on a given week was associated with a greater weight loss that same week; 1 (2%) demonstrated a statistically significant association in the unexpected direction, such that greater adherence to self-monitoring was associated with less weight loss.

A similar pattern was observed with self-weighing across all participants, such that each additional day of self-monitoring weight was associated with an average −0.05 ± 0.07 kg greater weight loss during the same week. Forty-two participants (58%) showed significant associations between the number of days self-monitoring weight and weight change. Of these, 40 (95%) demonstrated statistically significant associations in the expected direction, such that greater adherence to self-weighing on a given week was associated with greater weight loss that same week; 2 (5%) demonstrated statistically significant associations in the unexpected direction, such that greater adherence to self-weighing was associated with less weight loss.

Across both modalities of self-monitoring, 49 participants (68%) demonstrated statistically significant associations in the expected direction between self-monitoring of either caloric intake or weight. Of these 49 participants, 37 (76%) benefited from self-monitoring both caloric intake and weight, 9 (18%) benefited from self-monitoring caloric intake only, and 3 (6%) benefited from self-monitoring weight only.

There were no statistically significant differences in the magnitude of associations between self-monitoring of caloric intake or self-weighing and weight change by age, gender, race/ethnicity, education level, or income, all $ps > 0.05$ (see Table 2).

TABLE 1 Participant demographics and baseline characteristics ($N = 72$).

Demographic characteristic	M ± SD or *n* (%)
Age (years)	50.6 ± 10.3
Body mass index (kg/m^2)	31.2 ± 4.5
Gender	
Female	51 (70.8)
Male	21 (29.2)
Race/Ethnicity	
People of color[a]	12 (16.7)
Black or African American	7 (9.7)
American Indian/Alaskan Native	1 (1.4)
Asian	2 (2.8)
Native Hawaiian/Other Pacific Islander	0 (0.0)
Hispanic	2 (2.8)
Other	4 (5.6)
Non-Hispanic White	60 (83.3)
Education	
Less than college	21 (29.2)
College/University degree	32 (44.4)
Graduate/Professional	19 (26.4)
Income[b]	
$75,000 or less	21 (30.0)
$75,001-$100,000	17 (24.3)
$100,001-$125,000	10 (14.3)
$125,001+	22 (31.4)

[a]Participants could choose more than one race/ethnicity category, thus totals may exceed 100%.

[b]Two participants were missing data for income, thus percentages reflect a denominator of $n = 70$.

TABLE 2 Differences in associations between self-monitoring and weight change by demographic characteristics.

Demographic characteristic	Mean estimate for caloric intake	*p*-value	Mean estimate for self-weighing	*p*-value
Age	0.00025	0.679	<0.000	0.971
Gender				0.539
Female	−0.048	0.099	−0.042	
Male	−0.071		−0.054	
Race/Ethnicity				0.298
People of color[a]	−0.028		−0.025	
Non-Hispanic White	−0.060		−0.050	
Education				0.061
Less than college	−0.062		−0.071	
College/University degree	−0.043	0.228	−0.024	
Graduate/Professional	−0.066		−0.056	
Income[b]				0.573
$75,000 or less	−0.038	0.308	−0.027	
$75,001-$100,000	−0.052		−0.059	
$100,001-$125,000	−0.066		−0.055	
$125,001+	−0.067		−0.050	

4 | DISCUSSION

The current study characterised individual variability in the week-to-week associations between self-monitoring of caloric intake, self-weighing, and weight change in adults taking part in a 12-week behavioral weight loss program followed by a 40-week maintenance period during which no additional intervention was provided. Results demonstrated that, for most participants, greater self-monitoring of caloric intake and weight within a given week was associated with greater weight loss within the same week, supporting current clinical guidelines that advise participants in behavioral weight loss programs to engage in regular self-monitoring of caloric intake and weight.[1]

Although most participants in the current study benefited from self-monitoring caloric intake and self-weighing, results also demonstrated that self-monitoring was not effective for all participants; almost a third of participants did not demonstrate statistically significant associations between either self-monitoring of caloric intake or self-weighing and weight change. Unfortunately, the current study was unable to shed light on potential patterns in effectiveness between individuals, as no statistically significant differences in the effectiveness of self-monitoring were observed by age, gender, race/ethnicity, education, or income. It is possible that the inability to detect statistically significant differences could be related to power, due to the small sample size of this exploratory study. The size of effects reported in Table 2, however, also appear to have limited clinical importance. For example, the weekly difference in weight loss between men and women for each additional day of self-monitoring caloric intake was 0.023 kg/week, which would lead to a difference of 1.12 kg over the 52-week study year. This falls short of thresholds for defining clinically meaningful weight losses (e.g., reductions in risk for type 2 diabetes and improvements on related biomarkers are typically only observed with weight losses ≥2.5%).[1] As these results align with those of West and colleagues,[11] it is possible that demographic categories are not useful for distinguishing for whom self-monitoring will or will not be effective; future research should examine whether there are other individual-level factors that may be important.

Strengths of the current study include the use of a rich longitudinal dataset that included the frequency of self-monitoring and weight change each week for a full year; previous work in this area has been limited by the use of a questionnaire item to assess adherence to daily self-weighing. Further, this is the first study, to our knowledge, to characterize individual variability in the associations between self-monitoring and weight change in adults enrolled in a behavioral weight loss program. Although research has shown that self-monitoring is consistently associated with weight loss in such programs, it is important to understand individual variability in these associations, along with potential predictors of this variability, in order to guide the future development of novel, individually adaptive interventions.

The current study also had several important limitations. First, self-report data were used to assess adherence to self-monitoring; however, these data may not fully capture self-monitoring behavior as missing data can either indicate a day that self-monitoring was not completed or that data were not reported.[19] Related, participants were not provided with minimum thresholds to use for self-reporting

whether they self-monitored on a given day, which may lead to over-report of self-monitoring (e.g., participants reporting that they self-monitored caloric intake on a day when only one meal was recorded). Although previous research has demonstrated that, in relation to weight loss maintenance, overall adherence to self-monitoring may be more important than the *comprehensiveness* of self-monitoring records (i.e., whether all foods/drinks were recorded during the day),[20] it is also possible that this coding scheme could have influenced study results such that individuals who did not have significant negative associations between self-monitoring and weight change were the individuals who were less comprehensive in their self-monitoring of caloric intake. Unfortunately, the lack of detail on particular foods/drinks consumed precludes investigation into this question in the current study. As a second limitation, self-report data were used for assessing self-monitoring of both caloric intake and weight, despite the availability of e-scale weight data, to ensure consistency in measurement. Future studies should examine replication of these results with electronically captured self-monitoring data for caloric intake and weight (e.g., using both a study-provided smartphone app and e-scale). Finally, the study had a small sample size that may have been underpowered to detect significant differences between groups, and the sample was predominantly female, Non-Hispanic White (limiting comparisons by race/ethnicity to participants who identified as Non-Hispanic White vs. People of Color), and had a high education level and high income. Thus, the generalizability of results is limited; future research should investigate whether different patterns emerge in a larger sample that is more representative of the population of adults with obesity.

5 | CONCLUSION

The current study characterized individual variability in the associations between self-monitoring of caloric intake, self-weighing, and weight change in adults enrolled in a behavioral weight loss program. Results of the current study demonstrated that most (but not all) participants enrolled in a behavioral weight loss program benefitted from self-monitoring, supporting current clinical recommendations. Although almost a third of participants did not benefit from self-monitoring, there were no differences in effectiveness by age, gender, race/ethnicity, education, or income. Taken together with prior work from West and colleagues,[11] results suggest that demographic factors may have little utility for predicting the effectiveness of self-monitoring for weight loss, and that future research should focus on identifying other individual-level predictors.

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CONFLICT OF INTEREST STATEMENT

The authors declare no conflicts of interest.

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