RESEARCH ARTICLE

Measuring Adherence to a Nutrition and Exercise Lifestyle Intervention: Is Program Adherence Related to Excessive Gestational Weight Gain?

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Abstract To identify adherence required to achieve target health outcome(s) in nutrition and/or exercise interventions, a measurement tool that tracks objective and self-reported measures of adherence is necessary. The purpose of this study was to design an adherence measurement tool and test it retrospectively on the Nutrition and Exercise Lifestyle Intervention Program (NELIP; Ruchat et al., *Medicine and Science in Sports and Exercise*, 44(8), 1419–1426, 2012; Mottola et al., *Medicine and Science in Sports and Exercise*,

42(2), 265–272, 2010), designed to prevent excessive gestational weight gain (EGWG). The tool was based on the goals of the NELIP and included a grading system for each behavior (exercise and nutrition). It was used to determine whether adherence scores could differentiate excessive versus acceptable weight gain during pregnancy across pre-pregnancy body mass index (BMI) categories. Results showed irrespective of pre-pregnancy BMI, women with acceptable weight gain had significantly higher adherence ($p < 0.05$) than women with

Summary • Adherence to lifestyle interventions including a nutrition and exercise behavior change is necessary to evaluate and report because a lack of adherence can decrease the effectiveness of an intervention.

- By identifying the goals of an intervention and scoring participants throughout the intervention in meeting those goals, adherence can be measured and reported.
- Excessive gestational weight gain can be prevented by following a nutrition and exercise program during pregnancy; however, studies have yielded inconsistent results in women with a pre-pregnancy BMI of overweight or obese.
- By retrospectively measuring adherence to the NELIP, it was identified that greater adherence will result in the prevention of excessive gestational weight gain across all BMI categories.
- Future behavior change interventions targeting pregnant women should focus on increasing program adherence to increase the likelihood of preventing excessive gestational weight gain.

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excessive weight gain. It is recommended that this adherence tool be included in future prospective lifestyle intervention studies.

Keywords Adherence · Exercise · Nutrition · Gestational weight gain

Introduction

Adherence to lifestyle interventions that include behavior changes related to both nutrition and exercise can influence the efficacy of such interventions, yet there is currently no single method to track and report both objective and self-reported measures of adherence (Vitolins, Rand, Rapp, Ribsil, & Sevick, 2000). Lacking an adherence measurement tool substantially influences the interpretation of the effectiveness of behavior change interventions, potentially leading investigators to conclude an intervention to be ineffective, when a null effect may actually be explained by low adherence (Colditz & Taylor, 2010). This has been a challenge in nutrition and exercise behavior change interventions as lifestyle interventions often include both objective and self-reported goals for participants to meet, and there is currently no tool that can track and report both types of adherence measurements. Common objective measures of adherence in lifestyle interventions include attendance, pedometers, accelerometers, and other physiological measurement tools such as heart rate monitors (Vitolins et al., 2000); however, these measures are only appropriate for exercise-based behavior changes and usually used when the participant is in a face-to-face setting with the investigator. Lifestyle behavior change interventions may also include a nutrition component and additional exercise goals that are meant to be met outside of a laboratory or face to face setting. These measures may be self-reported, such as a food intake record, however, they are still important to track in order to capture the participant's full adherence to the intervention. An example of lifestyle interventions that would benefit from an adherence measurement tool that can track both objective and self-reported measures are exercise and nutrition behavior change programs designed to prevent excessive gestational weight gain (EGWG).

Maternal obesity and EGWG have been identified as key risk factors that contribute to the future onset of chronic diseases for both the mother and child including type 2 diabetes, cardiovascular disease, and obesity (Stüber et al., 2015; Siega-Riz & Laraia, 2006; Lee et al., 2015; Tarantal & Berglund, 2014). Furthermore, EGWG increases the likelihood of macrosomia (birth weight > 4000 g) which is associated with the development of childhood obesity (Bodnar, Siega-Riz, Simhan, Himes, & Abrams, 2010) thus, continuing a cycle of obesity for mother and her offspring (Ruchat & Mottola, 2012). Because of these factors, the Institute of Medicine

(IOM) produced guidelines for weight gain according to pre-pregnancy body mass index (BMI; Institute of Medicine, 2009). Healthy eating and physical activity implemented during pregnancy may prevent EGWG (Streuling, Beyerlein, & von Kries, 2010; Phelan, Jankovitz, Hagobian & Abrams, 2011; Choi, Fukuoka, & Lee, 2013). However, a systematic review found that overweight (BMI ≥ 25.0 – 29.9 kg m²) and obese (BMI ≥ 30.0 kg m²) women may be less likely to adhere (measured primarily by attendance) to interventions with the expectation to change two behaviors than normal weight (BMI ≥ 18.5 – 24.9 kg m²) women (Skouteris et al., 2010), leading to many interventions being reported as ineffective in preventing EGWG for women with a pre-pregnancy BMI of overweight or obese.

Studies that failed to prevent EGWG did not report an adherence measure or reported low attendance to the program (Nascimento, Surita, Parpinelli, Siani, & Pinto e Silva, 2011; Asbee et al., 2009; Guelinckx, Devlieger, Mullie, & Vansant, 2010; Oostdam et al., 2012). For example, a study that provided an at-home exercise program reported no effect on gestational weight gain; however, according to exercise logs, average adherence to the number of exercise sessions recommended was 62.5% (Nascimento et al., 2011). Similarly, Asbee et al. (2009) found that dietary counseling was effective in reducing weight gain but did not prevent EGWG for overweight or obese women, and they suggested this was because of a lack of attendance to counseling sessions. Guelinckx et al. (2010) reported no effect of a diet and exercise intervention on gestational weight gain for obese women even though nutrition behaviors had improved. Interestingly though, adherence for exercise was not measured and this could have influenced weight gain (Guelinckx et al., 2010). Finally, Oostdam et al. (2012) found no effect on gestational weight gain and prevention of gestational diabetes for overweight women on a nutrition and exercise program; however, adherence to the program was measured by attendance (17%) and this only captured the exercise behavior change goals, not nutrition. It is evident that a lack of adherence can reduce the effectiveness of a lifestyle intervention in preventing EGWG; however, there currently is no single method to track and report adherence to both objective (e.g., program attendance) and self-reported (e.g., exercise or nutrition logs) measures included in nutrition and exercise behavior change programs.

There have also been inconsistencies in the literature in regards to which behavior change (nutrition only, exercise only, or both exercise and nutrition) would be most effective in preventing EGWG across all pre-pregnancy BMI categories. Three randomized controlled trials which implemented a nutrition and exercise program for women with a pre-pregnant BMI ≥ 19.0 kg m² found that normal weight women met the IOM guidelines for gestational weight gain, while overweight and obese women exceeded weight gain recommendations (Polley, Wing, & Sims, 2002; Phelan, Phipps, Abrams,

Darroch, Schaffner & Wing, 2011; Hui et al., 2014). A similar trend was found in three systematic reviews which reported that normal weight women were more likely to meet IOM weight gain recommendations than obese and overweight women despite being on the same nutrition and exercise behavior change program (Kuhlmann, Dietz, Galavotti, & England, 2008; Dodd, Grivell, Crowther, & Robinson, 2010; Skouteris et al., 2010). One behavior change (nutrition) may be more successful than the second (exercise), as a systematic review suggested that dietary interventions may be more effective than an exercise intervention alone to prevent EGWG in overweight and obese women (Thangaratinam et al., 2012). In contrast, studies have reported that obese women were more likely to favor an exercise intervention, when asked which of these two behaviors (nutrition or exercise) they were more likely to change to prevent EGWG (Leslie, Gibson, & Hankey, 2013; Shub, Huning, Campbell, & McCarthy, 2013). Hence, an adherence measurement tool that assesses both exercise and nutrition behaviors is needed, in order to further shed light on which of the two targets (or the combination) of intervention are most critical to preventing EGWG.

Finally, little or no information exists on the degree of adherence required for nutrition and exercise behavior change programs to prevent EGWG. Successful studies looking at a single behavior change (exercise) across all pre-pregnancy BMI categories to prevent EGWG have used 70–80% attendance as an effective adherence measure for the intervention (Barakat, Pelaez, Montejo, Refoyo, & Coteron, 2014; Dominiques, Bassani, Coll Cde, da Silva, & Hallal, 2015; Haakstad & Bø, 2011); however, there is no evidence as to why this is an appropriate level of adherence to aim for and there is no evidence to confirm if this adherence goal is applicable across all pre-pregnancy BMI categories. An adherence measurement tool needs to be applied to a nutrition and exercise behavior change program to identify whether there is a difference in the amount of adherence required according to pre-pregnancy BMI to prevent EGWG.

The purpose of the present study was to design an adherence measurement tool that can combine and report objective and self-reported adherence measures for lifestyle interventions (nutrition and exercise behavior change) and test the tool on a retrospective study of pregnant women who participated in the Nutrition and Exercise Lifestyle Intervention Program (NELIP; Ruchat et al., 2012; Mottola et al., 2010) with the primary objective of preventing EGWG. The NELIP was selected because it targeted both nutrition and exercise behaviors and was applied across all pre-pregnancy BMI categories allowing for comparison of adherence according to behavior change (exercise, nutrition, or both) and by BMI. The tool, which was based on the goals of the NELIP program included a grading system for each behavior, and was used to determine whether adherence scores could differentiate excessive versus

acceptable weight gain during pregnancy across pre-pregnancy BMI categories.

We expected that irrespective of pre-pregnancy BMI, those who gained appropriate weight during the NELIP would report higher adherence scores than those who gained excessively. Furthermore, it seemed likely that normal weight women who gained appropriately would have greater adherence scores than overweight and obese women who gained appropriately, which may be why in previous studies normal weight women were more likely to gain appropriately than overweight or obese pregnant women.

Methods

Design of the Adherence Measurement Tool

From the published reports, a total of six goals were identified for the NELIP (Ruchat et al., 2012; Mottola et al., 2010). The nutrition component of the NELIP was based on a modified gestational diabetic diet and consisted of three goals. The first goal was to maintain an average daily energy intake of approximately 2000 kcal·d⁻¹, with a second goal of ingesting a daily carbohydrate intake of approximately 200–250 g and finally completing a 24 h food intake record for 1 day, submitted weekly during face-to-face laboratory visits (Ruchat et al., 2012; Mottola et al., 2010). Three exercise goals were identified from the NELIP intervention. The first goal was to attend one face-to-face laboratory visit to walk for 25 min, with 2 min added each week until 40 min was achieved and maintained for the remainder of the intervention (Ruchat et al., 2012; Mottola et al., 2010). Participants were also required to walk two additional times on their own for a total of three walking sessions every week (Ruchat et al., 2012; Mottola et al., 2010).

The NELIP dataset (from 2003 to 2009) was reviewed retrospectively for all participants and stratified according to pre-pregnancy BMI. The adherence criteria were applied to each participant, scoring their average nutrition and exercise behaviors on the NELIP. Based on the nutrition goals: one point was given if the overall average daily energy intake on the NELIP was 2000 kcal·d⁻¹ ± 10%, (1800–2200 kcal·d⁻¹), one point was awarded if the overall average daily carbohydrate intake was between 200–250 g, and a third point was given as a percentage of that point by dividing the number of submitted food intake records by the total number of expected food intake records (one per week for the duration of the program). Based on the exercise goals, an average number of walking sessions per week was considered a score out of 3 (one point per walking session, length of each walking session progressed according to the program week). If participants walked more than three times per week on average, they were still given a perfect score out of three. Table 1 describes

Table 1 Calculation of adherence tool scores

Goals of the program	Description of calculation	Points allocated
Nutrition goal: total average daily energy intake	Average daily intake throughout the program of: 2000 kcal day ⁻¹ $\pm$ 10%, (1800–2200 kcal day ⁻¹)	/1
Nutrition goal: total average daily carbohydrate intake	Average daily intake throughout the program of: 200–250 g	/1
Nutrition goal: submission of food intake records (FIR)	Total number of FIRs submitted $\div$ total number of expected FIRs (based on number of weeks on the program; 1 submission per week)	/1
Total nutrition score		/3
Exercise goal: face-to-face lab visit for one walking session	Attending one walking session in the lab per week	/1
Exercise goal: walking one time on their own	Walking one time on their own for a total of 2 walking sessions per week	/1
Exercise goal: walking a second time on their own	Walking two times on their own for a total of 3 walking sessions per week	/1
Total exercise score	An average of how many times they walked per week was calculated for a total score out of 3 for exercise. If participants walked on average more than 3 times per week, they were still assigned a score of 3 for meeting all exercise goals.	/3
Total adherence score	Total nutrition + total exercise score	/6

each goal, how the goal was scored, and the total points for each goal. Due to the retrospective nature of the study, scores were reviewed and confirmed by original NELIP investigators to assure all scores correctly reflect each participant's adherence to the program.

Calculation of Excessive Gestational Weight Gain from NELIP Database

Data were extracted for pre-pregnancy BMI, weight at the beginning of the intervention (participants were anywhere between 16 to 20 weeks gestation), and at the end of the intervention (participants were anywhere between 36 to 40 weeks gestation; Ruchat et al., 2012; Mottola et al., 2010). Total weight gained on the NELIP was calculated by subtracting their weight from the start of the intervention (16 to 20 weeks gestation) from their weight at the end of the intervention (36 to 40 weeks).

According to the IOM (2009) guidelines, pregnant women are expected to gain 2 kg in their first trimester regardless of their pre-pregnancy BMI status. To calculate excessive weight gain on the NELIP, we determined the maximum recommended weight gain during pregnancy for each BMI group according to the IOM (2009) guidelines and subtracted the calculated expected amount of weight gain by 16 to 20 weeks gestation. EGWG was defined as greater than 4.8–5.9 kg for obese, 6.9–8.2 kg for overweight, and 10.0–12.0 kg for normal weight women, depending on the total number of weeks they were engaged in the program. Six groups were identified: obese gained appropriately (OBA), obese gained excessively (OBE), overweight gained appropriately (OWA), overweight gained excessively (OWE), normal weight gained appropriately (NWA), and normal weight gained excessively (NWE).

Analysis

To identify the degree of adherence required for each behavior change, an average exercise adherence score (out of three points), an average nutrition adherence score (out of three points), and an average total score (maximum six points) were determined for each of the six groups. These scores were converted to a percentage to represent an average adherence score required for each behavior change (nutrition, exercise) and the total score necessary to prevent EGWG based on pre-pregnancy BMI status.

A univariate analysis of variance was performed across all six groups to identify differences in adherence within and across BMI categories with an effect size calculation (η^2) for adherence to nutrition only, exercise only, raw total score, and total score presented as a percentage. Statistical analyses were conducted using SPSS (Version 23).

Results

We retrospectively analyzed 136 participants from the NELIP dataset to evaluate adherence to the two-behavior change components (nutrition and exercise) of the intervention. Thirty-eight participants had a pre-pregnancy BMI status of obese, of which 21 gained appropriately on the NELIP while 17 gained excessively. There was a significant difference in weight gained on the NELIP ($p = 0.001$) between OBA and OBE. OBA adherence scores were significantly greater than the OBE category with a large effect size for adherence in exercise only ($p = 0.001$; $F = 13.8$, $\eta^2 = 0.3$), and total adherence ($p < 0.001$; $F = 17.9$, $\eta^2 = 0.4$). Adherence scores for nutrition only were greater in the

OBA category compared to OBE; however, this was not significant ($p = 0.125$; $F = 2.3$, $\eta^2 = 0.08$).

Forty-five participants had a pre-pregnancy BMI status of overweight. Twenty-eight gained appropriately while on the NELIP and 17 gained excessively. There was a significant difference in weight gained on the NELIP ($p = 0.001$) between OWA and OWE. OWA adherence scores were significantly greater than OWE with a large effect size for exercise adherence ($p = 0.001$; $F = 13.8$, $\eta^2 = 0.3$) and total adherence ($p = 0.001$; $F = 17.9$, $\eta^2 = 0.4$). Adherence scores for nutrition only were greater in the OWA category than OWE; however, this was not significant ($p = 0.986$; $F = 2.3$, $\eta^2 = 0.08$).

Fifty-three participants had a pre-pregnancy BMI status of normal weight, of which 51 gained appropriately on the NELIP and only two gained excessively. Similar to the overweight and obese participants, weight gained on the NELIP was significantly different between NWA and NWE ($p = 0.001$). Although there were only two participants in the NWE category, NWA total adherence was significantly greater than NWE with a large effect size ($p = 0.008$; $F = 17.9$, $\eta^2 = 0.4$). NWA exercise only ($p = 0.104$; $F = 13.8$, $\eta^2 = 0.3$) and nutrition only ($p = 0.596$; $F = 2.3$, $\eta^2 = 0.08$) scores were greater than NWE; however, these were not significant ($p = 0.596$; $F = 2.3$, $\eta^2 = 0.08$).

No differences in adherence were observed across the OBA, OWA, and NWA categories. Total weight gained on the NELIP is presented in Table 2. Mean adherence values for exercise only, nutrition only, and total adherence with 95% confidence intervals are reported in Table 3.

Discussion

Objective and self-reported measures of adherence to the NELIP were retrospectively analyzed to determine whether adherence scores could discriminate excessive versus acceptable weight gain during pregnancy across pre-pregnancy BMI categories. As expected, in all BMI categories, adherence scores were significantly greater for those women who met gestational weight gain recommendations compared to those who gained excessively. These results suggest that, irrespective of pre-pregnancy BMI, adherence to the program's nutrition and exercise goals can prevent EGWG. Women with a pre-pregnancy BMI of obese require on average 80% adherence to the full behavior change program while overweight women require 67% and normal weight women require 77% to prevent EGWG.

Women with a normal pre-pregnancy BMI who gained appropriately had similar adherence scores to women with a pre-pregnancy BMI of overweight or obese who also gained appropriately. These results contradict those of previous studies on exercise and nutrition interventions, which have been more successful in normal weight populations than

Table 2 Total weight gained on the NELIP

BMI categories <i>n</i> = 136	Total weight gained on the NELIP (kg)
OBA (<i>n</i> = 21)	3.6 ± 2.5 ^a , [2.6, 4.7]
OBE (<i>n</i> = 17)	10.8 ± 1.9 ^a , [9.7, 11.8]
OWA (<i>n</i> = 28)	6.1 ± 2.3 ^a , [5.2, 7.0]
OWE (<i>n</i> = 17)	13.4 ± 3.2 ^a , [11.7, 15.2]
NWA (<i>n</i> = 51)	8.6 ± 2.4 ^b , [7.9, 9.2]
NWE (<i>n</i> = 2)	15.9 ± 1.3 ^b , [4.5, 27.3]

Data are mean ± standard deviation, 95% confidence intervals for mean
OBA obese gained appropriately, OBE obese gained excessively, OWA overweight gained appropriately, OWE overweight gained excessively, NWA, normal weight gained appropriately, NWE normal weight gained excessively

^a Indicates statistical significance within groups for each BMI status ($p < 0.001$)

^b Indicates statistical significance within groups for each BMI status ($p = 0.001$)

overweight or obese (Skouteris et al., 2010). Instead, our results suggest that nutrition and exercise interventions are effective in all pre-pregnancy BMI categories as long as participants are adhering to the program. Women who gained appropriately had significantly greater adherence than women who gained excessively across all BMI categories.

Previous lifestyle interventions designed to prevent EGWG and other pregnancy-related health outcomes have used attendance as an adherence measure, and programs with higher attendance have been more likely to prevent EGWG. For example, a successful educational intervention which provided individual counseling on weight gain recommendations, exercise and nutrition habits, reported a 75% attendance rate from participants who met the IOM weight gain recommendations (Shirazian, Faris, Fox, Friedman, & Rebarber, 2016). An exercise-only intervention reported a very high attendance rate with all participants attending 80% or more of exercise sessions and this intervention was successful in preventing incidents of hypertension and macrosomia in women from all pre-pregnancy BMI categories (Barakat et al., 2015). Similarly, an exercise intervention that prevented gestational diabetes reported 80% attendance to all exercise sessions (Cordero, Mottola, Vargas, Blanco, & Barakat, 2015). A systematic review looking at the effects of dose of exercise on preventing EGWG consistently found a high attendance rate among studies that were successful (McDonald, Liu, Wilcox, Lau, & Archer, 2016). Attendance however does not capture adherence to a lifestyle intervention that includes both nutrition and exercise behavior changes and research has shown that interventions with both behaviors (nutrition and exercise) are more likely to succeed in preventing EGWG than just one behavior change (Nascimento, Pudwell, Surita, Adamo, & Smith,

Table 3 Mean adherence scores for nutrition only, exercise only and total adherence

BMI categories <i>n</i> = 136	Adherence to nutrition /3,	Adherence to exercise /3	Adherence to both exercise and nutrition /6
OBA (<i>n</i> = 21)	2.0 (67%), [1.7, 2.4]	2.8 (93%) ^a , [2.5, 3.1]	4.8 (80%) ^a , [4.4, 5.2]
OBE (<i>n</i> = 17)	1.3 (43%), [0.9, 1.7]	1.7 (57%) ^a , [1.3, 2.0]	3.0 (50%) ^a , [2.5, 3.4]
OWA (<i>n</i> = 28)	1.7 (57%), [1.4, 2.0]	2.4 (80%) ^a , [2.1, 2.6]	4.0 (67%) ^b , [3.7, 4.4]
OWE (<i>n</i> = 17)	1.5 (50%), [1.1, 1.9]	1.3 (43%) ^a , [1.0, 1.7]	2.8 (47%) ^b , [2.4, 3.3]
NWA (<i>n</i> = 51)	1.9 (63%), [1.7, 2.1]	2.7 (90%), [2.5, 2.9]	4.6 (77%) ^c , [4.4, 4.9]
NWE (<i>n</i> = 2)	0.9 (30%), [−0.3, 2.1]	1.3 (43%), [0.2, 2.3]	2.2 (37%) ^c , [0.9, 3.5]

Data are mean raw scores (score converted to a percentage), [95% confidence intervals for mean raw score]

OBA obese gained appropriately, *OBE* obese gained excessively, *OWA* overweight gained appropriately, *OWE* overweight gained excessively, *NWA* normal weight gained appropriately, *NWE* normal weight gained excessively

^a Indicates statistical significance within groups for each BMI status ($p < 0.001$)

^b Indicates statistical significance within groups for each BMI status ($p = 0.001$)

^c Indicates statistical significance within groups for each BMI status ($p = 0.008$)

2014). Therefore, an adherence measurement tool that includes both objective measures (e.g., attendance to exercise sessions) and self-reported measures (e.g., food intake records) is needed.

Simply by identifying the goals of the program and scoring participants on meeting those goals throughout the intervention, adherence to both objective and self-reported measures can be reported. Although self-report measures suffer from significant limitations, they are likely necessary when interventions aim to change lifestyle behaviors that occur outside of experimenter presence and for which behaviors cannot yet be measured by automated electronic means (e.g., food eaten). Furthermore, self-regulation of behavior change has been shown to be an effective strategy in changing nutrition and exercise behaviors (Anderson, Winett, & Woicik, 2007). For example, a behavioral intervention designed to prevent EGWG found that pregnant women with a pre-pregnancy BMI of obese that self-monitored their weight gain and tracked meeting their nutrition and exercise goals, gained less weight during their pregnancy than women receiving normal prenatal care (Krukowski et al., 2016). This adherence measurement tool allows for tracking self-regulatory practices and captures full program adherence by scoring participants on meeting self-reported goals and objective goals. As such, this tool is not offered as a replacement for objective tools, such as accelerometers or heart monitors, but rather as a tool that can incorporate the use of objective measures, as well as subjective measures, to construct a comprehensive picture of overall adherence.

Our study found that nutrition and exercise interventions designed to prevent EGWG can be effective in all pre-pregnancy BMI categories if participants adhere to the goals of the intervention. A limitation of the current study was the retrospective design. However, there are benefits to measuring adherence retrospectively. A retrospective analysis of

adherence allows for the identification of non-adherence patterns. Investigators can identify which program goals or participant characteristics, such as BMI, may have led to a lack of adherence (Martin, Bowen, Dunbar-Jacob, & Perri, 2000). A retrospective analysis of adherence to nutrition and exercise goals provides insight as to which behavior change may increase the likelihood of achieving the desired health outcome and what areas of the intervention require improvement to increase program adherence. Investigators can then strategize accordingly to improve adherence in a prospective study. The next step for this investigation would be to test the adherence measurement tool in a prospective experiment, tracking participant behavior throughout the intervention. A second limitation was very low sample in the NWE group (only two participants); however, this reflects the success of the program in the normal weight population and may suggest that normal weight women are more likely to adhere to two behavior changes simultaneously (nutrition and exercise) than overweight and obese pregnant women. Future research could attempt to address this possibility directly.

A strength of the current study is the potential universality of the adherence measurement tool for behavior change interventions. The adherence tool can be adjusted for any behavior change by identifying the components of adherence to the program and scoring participants throughout the intervention in meeting those parameters. Future investigators could thereby identify the average adherence required to achieve desired intervention outcomes and future similar interventions could strive towards that goal. Therefore, the flexible nature of the current adherence tool will likely allow researchers to track adherence to a wide variety of lifestyle-based prescriptions or recommendations. Future studies should extend the use of the current tool to other behavioral health interventions.

Conclusion

Adherence to nutrition and exercise lifestyle interventions can be measured by identifying the behaviors required for adherence to the program and scoring participants in executing those behaviors throughout the intervention. This method was applied to retrospectively measure adherence to the NELIP. Women who met the IOM guidelines for weight gain during pregnancy had significantly greater adherence to the full program than women who gained excessively, irrespective of pre-pregnancy BMI category. These results suggest that the success of a nutrition and exercise behavior change program designed to prevent EGWG may be dependent on the adherence to the program goals, not necessarily pre-pregnancy BMI. Future interventions should focus on increasing program adherence to prevent EGWG, and the current tool could be employed as a dependent variable in such studies.

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Compliance with Ethical Standards

Conflict of Interest The authors declare that they have no conflict of interest.

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