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Feasibility of the flipped classroom approach for health education in a clinical weight loss program

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ABSTRACT

Aim: To assess the feasibility of the flipped classroom pedagogy in a clinical weight loss program and its impact on 6-month weight change.
Methods: Adults with overweight/obesity enrolled in a 6-month program with a structured diet (portion-controlled meals and fruits/vegetables) and exercise plan (≥150mins/week), plus weekly, 1-h group education sessions. Sessions used a flipped classroom approach: educational content was delivered beforehand via podcast/video and book readings and session time involved application-based activities (e.g., case studies, games). Satisfaction surveys were completed at 3 months. Weight change was assessed using paired *t*-tests (SAS 9.4, significance 0.05).
Results: Eighteen participants completed 6 months (retention 94%). Participants maintained diet adherence and exercise at 3 months (~84% diet adherence, ~153mins exercise/week) and 6 months (~83% diet adherence, ~158mins exercise/week), as well as attendance to behavioral sessions (3 months: 77%; 6mo: 71%). Satisfaction surveys showed high program enjoyment (~8.1/10). Mean weight change at 3 and 6 months was $-6.5 \pm 4.2\%$ and $-9.3 \pm 5.0\%$ (both $p < 0.01$), respectively.
Conclusion: The flipped classroom pedagogy was feasible for delivery in a clinical weight loss program and supported significant 6-month weight loss.
Innovation: This is the first evaluation of the flipped classroom in a clinical setting and supports the investigation of this pedagogy in weight management.

1. Introduction

Obesity remains a global health problem, with prevalence rates reaching 603 million adults [1]. Obesity is associated with an increased risk for mortality, cardiovascular diseases, and certain cancers [2,3], as well as psychological conditions including clinical depression and anxiety [4,5]. As little as 5–10% body weight loss can improve obesity-related health complications [6,7], which can be achieved through a multi-component program aimed at reducing energy intake, increasing energy expenditure with exercise, and intensive behavioral counseling. Despite the recognized importance of behavioral counseling for weight management [8,9], there is an overall lack of pedagogy (i.e., approaches to teaching and learning) behind weight management program education. The majority of educational content in weight management programs and interventions is delivered in a traditional format (advice, brochure, booklet, etc.) [8,9] without investigation into the delivery of different educational learning theories/models. Investigation of pedagogy in weight management education is virtually absent in the research literature and it is warranted to investigate given the rising obesity epidemic.

An educational model used in academic institutions, deemed the active learning model [10], may serve as a feasible educational model used in weight management interventions. The active learning model is a variation of the traditional education model which re-distributes the responsibilities of reviewing educational content and applying practical skills between the educator and student, thus receiving the name "flipped classroom" [11-13]. In a traditional education model, the educator presents educational materials during class times, then the students

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independently complete skills-based homework assignments outside of class [11-13]. In contrast, the flipped classroom requires students to independently review educational material before class, and class time with the educator is spent engaging in group and individual skills-based activities and problem-solving assignments [11-13]. The flipped classroom is a multimodal approach that includes visual, auditory, reading, writing, and kinesthetic styles in the prescribed sequence of pre-work and skills-based activities [11-13]. Utilizing a multimodal approach improves learning experience and boost attention [14-16] and is shown to be effective in patient education programs [17,18]. The theoretical basis for the development of the flipped classroom is to elicit higher cognitive learning, according to the revised Bloom's taxonomy [19,20]. Progression of learning outcomes from low to high cognition are 1) remembering, 2) understanding, 3) applying, 4) analyzing, 5) evaluating, and 6) creating [19]. Thus, the flipped classroom pedagogy shifts independent student time to passive learning (remembering and understanding) and collaborative student and educator time to active learning (applying, analyzing, evaluating, and creating) [19].

When used in academic institutions, the flipped classroom has been shown to increase student test scores, learning, engagement, and skill acquisition in a variety of health and science-related topics [10,11,21-23]. More specifically, investigators believed mechanisms behind the improvement in student learning were ownership of learning and flexibility [21], self-efficacy and preparation [10,23], and self-awareness and problem-solving [22]. Despite evidence supporting the flipped classroom, this educational model is at odds with the general advice-giving style that is predominant in current weight management education delivery [8,9]. Previous research shows enhanced weight loss with improved self-efficacy [24] and self-awareness via self-monitoring [25] in adults during a weight management intervention, supporting the inference that a pedagogy approach with outcomes that enhance student learning in academic institutions may be an effective pedagogy for weight management education. Therefore, the purpose of this investigation was to evaluate the feasibility of implementing the flipped classroom pedagogy within a clinical weight loss program.

2. Methods

2.1. Participants

This was a non-randomized, single-armed trial with a convenience sample of adults (goal $n = 18$) recruited from an outpatient weight management clinic at an academic medical center between 2021 and 2022 using referrals from local clinicians, online applications, and word of mouth. Eligibility criteria included ≥18 years of age with a body mass index (BMI) ≥ 25 kg/m^2. Exclusion criteria included the following: 1) receiving professional treatment for an eating disorder within the last 6 months, 2) engagement in a structured weight management program within the last 6 months, 3) current use of an anti-obesity medication, 3) a self-reported inability to engage in moderate to vigorous physical activity, and 4) food intolerances/allergies that prohibited adherence to the dietary prescription. Interested and eligible participants completed a 45-min Zoom® meeting with a program coordinator to review intervention expectations, ask questions, and provide written informed consent. This study was approved under the Institutional Review Board at the University of Kansas Medical Center.

2.2. Curriculum development

The flipped classroom health education sessions were adapted from an existing traditional weight management group class curriculum and tested for acceptability in a small, volunteer sample of existing adults in the weight loss clinic ($n = 5$). The volunteers independently reviewed example lessons using the two methods of delivering educational content (i.e., audio recording/podcast and audio-visual videos posted online) and then met virtually with the research team to discuss the likeability of the layout, content, and delivery. Then, the volunteers completed mock health education sessions to provide feedback on the flipped classroom curriculum. Discussed feedback included adjusting the level of difficulty, enhancing group engagement, and increasing application-based activities. The provided feedback was incorporated into the flipped education curriculum as needed.

2.3. Delivery of educational content

To implement the flipped classroom, the delivery of educational content was split into two multimodal learning activities, 1) independent review of educational content prior to the session, and 2) group-based learning activities during remote health education sessions. A total of 24 pre-work content and application-based activities were developed to correspond with the 24 weeks of health education curriculum. Educational content was provided via email one week in advance of the group health education sessions. Participants were asked to independently review the content at a time and place that was most feasible in their schedule. The educational content was created by the research team and constituted either an audio/visual video or audio only podcast (all ~10 min) plus a program book with reading chapters corresponding to each lesson (~20 mins). The videos/podcasts and book chapters provided the background knowledge needed for application in the upcoming group health education sessions and included information such as 1) recommended portion sizes by food group per meal, 2) strategies for building an exercise plan, and 3) review of information included on a food label. Participants were encouraged to review the educational content as many times as necessary to absorb the information. In total, pre-work takes about 30 min for the participants each week.

Following the review of educational content, participants attended a group-based health which included group-based learning activities to apply the information. Participants completed a total of 24 group health education sessions, each lasting for 60 min, once a week delivered remotely via Zoom®. The 60 min were utilized as follows, 1) check-in question and review of information provided in the educational videos/podcasts and book chapter (~5 mins), 2) review of self-monitoring of diet and exercise prescription adherence and problem-solving barriers to adherence (~10 mins), 3) group-based learning activity (~40 mins), and 4) assignment of next-week's topic and educational video/podcast and book chapter to be reviewed (~5 mins). Examples of group-based learning activities include solving case studies aimed at increasing fruit and vegetable intake, developing written exercise plans for weekdays and weekends, participating in games evaluating knowledge of correct portion sizes of the 5 major food groups, and evaluating nutrition content of a meal based upon a written recipe and food labels.

2.4. Diet prescription

The dietary approach used in this trial has been used successfully in previous studies conducted by the research group [26,27]. Energy intake was reduced to approximately 1200–1500 kcal /day using a combination of commercially available portion-controlled meals (PCMs) (Health Management Resources, Boston, MA, USA) and fruits and vegetables (fresh, frozen, or canned). Participants were instructed to consume a minimum daily total of three shakes (100 kcal each), two entrees (140–270 kcal each), and five one-cup servings of fruits and vegetables. Participants were encouraged to consume zero and low-calorie beverages, as well as utilize condiments/additions with <15 kcals/tablespoon with a maximum of 4 additions per day (total < 60 kcals). Participants were provided example daily meal plans and recipes for additional assistance.

2.5. Exercise prescription

The exercise prescription was based on national guidelines and expert recommendations for exercise and weight loss [28]. Participants received a target goal of 150 min/week of moderate-to-vigorous intensity activity (MVPA) with progression to 300 mins/week MVPA and 10,000 steps/day as able. The exercise prescription started at 45 mins MVPA/week and 3000 steps/day at baseline and progressed an additional 15 mins/week and 500 steps/day until reaching the target goal at month 3 and remained at the target until month 6. Participants were instructed to only include MVPA (e.g., brisk walking, running, fast bicycling) versus leisurely movement (e.g., gardening, house cleaning) in their daily tracking of exercise minutes.

2.6. Self-monitoring

Participants provided self-monitoring data weekly to a health educator via email using a tracking sheet provided by the research team. Diet and exercise data included self-reported daily consumption of PCM shakes, PCM entrée's, cups of fruit and vegetables, days off plan (consuming food and/or drinks not approved for program), as well as daily minutes of MVPA and step count. Participants were instructed to weigh weekly on a home scale wearing minimal clothing and report their weight to the health educator the day of the educational session. Data provided from participants was stored in a REDCap database protected for security under the University of Kansas Medical Center.

2.7. Surveys

At baseline, participants were asked to complete a digital health history survey to answer questions regarding demographic information, previous weight loss attempts, and pre-existing health conditions. There was no exclusion criterion related to pre-existing health conditions or previous weight loss attempts to increase generalizability to outpatient weight management clinics. An independently developed satisfaction survey was completed at 3 months to evaluate perceptions towards content design, delivery, and support towards weight goals using 1–10 scales and open-ended questions. All surveys were completed digitally and stored in a secured REDCap database.

2.8. Statistical analysis

Sample demographics and characteristics were summarized using descriptive statistics. Changes in nutrition, exercise, and weight outcomes from baseline to 3 and 6 months were evaluated using paired *t*-tests without covariates. Correlation between weight change and measures of adherence and attendance were evaluated using a Spearman's rank correlation analysis. All statistical analyses were completed in SAS 9.4 or higher (significance level 0.05).

3. Results

3.1. Sample demographics and characteristics

Nineteen adults were initially enrolled in the feasibility trial. One participant dropped out after 11 weeks due to conflicting time commitments. A final sample of 18 adults were included in the analyses, resulting in a 6-month retention rate of 94.7%. Participants were primarily White and female. Demographic characteristics are provided in Table 1.

Participants in this study had multiple self-reported obesity-related comorbid conditions, such as diabetes (88%) and sleep apnea (52.9%). Additionally, they reported low previous levels of success in healthy weight management behaviors (e.g., increased physical activity, reduction of energy intake). Eighty percent reported ≥3 previous weight loss attempts in the last year, but <25% reported a history of working with a healthcare professional (i.e., registered dietitian, doctor or nurse, personal trainer), indicating the majority of previous weight loss attempts were completed without guidance. Although 81.5% reported having successfully lost over 20 pounds in previous attempts, more than half (56.3%) were unable to maintain the weight loss for longer than 6 months. Roughly 1/3rd of the sample reported zero engagement in exercise in the last 6 months prior to the intervention.

Table 1
Baseline demographics of the study sample ($n = 18$).

	Mean ± SD
Age (years)	51.8 ± 17.8
Sex (n, %)	
Male	5 (27.8)
Female	13 (72.2)
Race (n, %)	
White	16 (88.8)
African American	1 (5.6)
Asian American	1 (5.6)
Weight (kg)	105.7 ± 20.3
BMI (kg/m^2)	37.9 ± 9.4
Pre-Existing Health Conditions (n, %)	
High cholesterol	7 (38.9)
Sleep apnea	9 (50.0)
Hyperglycemia	6 (33.3)
Hypertension	8 (44.4)
Heart disease	3 (16.7)
Arthritis	7 (38.9)
Thyroid problems	5 (27.8)
Diabetes	15 (83.3)

Note. Body Mass Index (BMI).

3.2. Attendance and self-monitoring

Mean attendance to the health education sessions was 76.7% at 3 months and 70.8% at 6 months (mean 17.1 ± 5.0 out of 24 sessions). Mean completion of weekly self-monitoring was 69.2% at 3 months and 63.3% at 6 months.

3.3. Diet and exercise

Adherence to the diet prescription was maintained from week 1 throughout 6 months of the intervention. (Table 2). Participants significantly increased their minutes of MVPA/week from week 1 to 3 months (mean change 19.1 ± 35.5 mins/wk., $p = 0.03$) and 6 months (mean change 24.8 ± 58.2 mins/wk., $p = 0.03$). Weekly steps increased at 3 months and 6 months, but these changes were not significant ($p > 0.05$).

Table 2
Diet and exercise at Week 1, 3 Months, and 6 Months.

	Prescribed Goal	Week 1 (n = 19)	Month 3 (n = 18)	Month 6 (n = 18)
PCM Shakes / wk	21	16.1 ± 4.9	16.2 ± 4.9	15.0 ± 5.1
PCM Entrees / wk	14	11.7 ± 2.9	11.8 ± 2.9	12.3 ± 2.7
Fruits and Vegetables / wk	35	31.1 ± 6.9	30.8 ± 3.6	31.5 ± 4.0
Days Off Plan / wk	0	1.5 ± 1.0	1.9 ± 0.9	1.9 ± 1.2
Exercise Minutes / wk	150 to 300	133.8 ± 73.6	152.8 ± 68.4*	158.6 ± 84.3*
Steps / wk	70,000	35,584.4 ± 16,212.5	38,086 ± 14,839.4	38,996.0 ± 12,997.5

Note. Data presented as mean ± SD. Portion-Controlled Meal (PCM). *Indicates significant change from week 1, $p < 0.05$.

3.4. Weight change

Weight change at 3 and 6 months are presented in Table 3. Participants achieved significant weight loss at 3-months (−6.5 ± 4.2%, $p < 0.01$) and 6-months (−9.3 ± 5.0%, $p < 0.01$). Fourteen of the 18 participants (~78% of the sample) achieved clinically significant weight loss (≥5% initial body weight over 6 months) and 33% lost ≥10% initial body weight over 6 months. Greater weight change at 6 months was correlated with weekly self-monitoring ($\rho = -0.5$, $p = 0.03$), adherence to the nutrition prescription ($\rho = -0.7$, $p < 0.01$), and increased minutes of weekly MVPA ($\rho = -0.5$, $p = 0.05$).

3.5. Satisfaction

At 3 months, 13/18 participants completed a program satisfaction survey. The ranked satisfaction for both the overall health education delivery style and pre-work content was 8 on a 10-point scale (1 being low, 10 being high). When asked to identify the health education approaches perceived as most enjoyable, the 4 answers reported were game play (33%), instructor-led exercise (33%), case studies (33%), and group-based brainstorming activities (42%). Reported reasons for enjoyment of these approaches were that they facilitated engagement in a remote environment, allowed for group involvement, and provided learning application to real-world scenarios. When asked what approaches were perceived to be unenjoyable, one participant cited game play as it did not feel appropriate for the clinical setting, and one participant cited breakout rooms as it restricted conversation among the group as a whole.

4. Discussion and conclusion

4.1. Discussion

The flipped classroom pedagogy proved feasible for delivery in a clinical weight loss program in adults with multiple obesity-related comorbidities and a lack of previous success in weight loss attempts. Participants reported high enjoyment of the educational approach due to promotion of group engagement during health education sessions. Participants achieved a mean weight loss of 9.3% and > 150 mins/week of MVPA by 6 months, which meet the weight loss and physical activity recommendations provided from the 2013 obesity guidelines [28]. Adherence to the diet prescription was maintained through the duration of the program. Through the support of a structured diet and exercise plan, a flipped classroom approach to health education may serve as an effective pedagogy strategy for clinical weight loss programs.

Diet and exercise adherence are strong predictors of weight loss [29,30], although maintenance of these behaviors throughout an intervention can be difficult. The flipped classroom approach supported nearly identical adherence to the nutrition prescription and increased MVPA from week 1 through 6 months (Table 2). A 2016 meta-analysis of 27 studies found diet and exercise adherence in lifestyle-based weight loss interventions is poor, averaging at 60.5% (95% CI 53.6–67.2) [31], thus intervention strategies that address adherence are imperative. Furthermore, attendance to health education sessions is highly correlated to weight loss [32], specifically attendance in the first 12 weeks of an intervention [33]. Participants in this trial maintained at least 70% attendance to group health education sessions by 3 months and maintained this level of attendance through 6 months. Our findings of maintained diet/exercise adherence and session attendance may be related to the participants' high enjoyment of the flipped classroom reported in the 3-month satisfaction surveys. Participants found the group-based learning activities applicable to their weight loss efforts and effective for promoting behavior change. Future studies may evaluate the flipped classroom approach in a behavioral weight maintenance intervention to evaluate potential for impacting long-term lifestyle change.

It is well-established that behavioral counseling is a foundational aspect of weight management programs [28]. Despite its emphasized importance, there is an overall lack of pedagogy investigating different approaches to promotion of long-term lifestyle change. We are not aware of any previous intervention trials that have evaluated the flipped classroom approach in a clinical weight loss program, thus comparison to other findings cannot be completed. Future studies should build upon the feasibility shown in this trial to further evaluate the effectiveness of this pedagogy approach in promoting lifestyle and weight-related behavior change. In addition to measuring short and long-term changes in weight, outcomes should be behavior-related measures that may serve as the drivers of weight change, such as adherence to nutrition/exercise prescriptions, attendance to health education sessions, long-term health behavior change, and program enjoyment.

This feasibility trial did not include cost analysis measures, although future work may benefit from measuring the time and cost associated with building and delivering a flipped classroom weight loss intervention relative to total weight loss. The content used in this trial was adapted from pre-existing materials and therefore was very feasible to develop, estimated at around 60–90 min per weekly lesson. A formal cost analysis can help conceptualize the feasibility of the flipped classroom implemented in a weight loss clinic when the videos, podcasts, and application-based learning activities are built from scratch. We can, however, estimate the total time for the participants weekly. The total estimated time per week for participants is ~100 min (30 mins pre-work, 60-min class, 10 mins self-monitoring). Additionally, we were unable to measure the length of time participants spent viewing the pre-work educational content or if the content was viewed at all. However, the beginning of each health education session began with a 5-min check-in period to ensure participants understood the information and feedback on the 12-week satisfaction survey ranked satisfaction with the pre-work videos/podcasts an 8/10. Therefore, we can infer that the pre-work educational content was feasible for participants.

The limitations of this study should be noted. The primary aim of the trial was feasibility, as such, more extensive outcome measurements were not included, and the trial did not include a control group or randomization. A small sample size was used to evaluate feasibility, thus larger and more diverse samples will be needed for future research studies. Finally, the flipped classroom pedagogy was applied within a structured multi-component weight loss program, and thus there is caution in interpreting results as arising from the pedagogy approach alone versus the high level of support coming from the program. The feasibility shown in this trial can be built upon with future studies evaluating the flipped classroom pedagogy using a control group comparison and for a longer duration.

4.2. Innovation

The investigation of pedagogy in weight management is absent in the literature despite the importance of patient health education in weight reduction. Given the rise of obesity rates, evaluating health education strategies to enhance the effectiveness of weight loss interventions and support long-term lifestyle change is imperative. Our trial showed the feasibility of the flipped classroom approach for health education in a clinical weight loss program, which is a well-supported pedagogy in academic institutions that has yet to receive investigation in a clinical setting. To our knowledge, this trial is the first application of the flipped classroom pedagogy in a clinical program and may serve as the foundational work to support future research investigating pedagogy

Table 3
Weight change at 3 and 6 Months (n = 18).

	3 Months	6 Months
Weight (kg)	−7.0 ± 4.1 (0 to −16.4)*	−10.0 ± 4.9 (+1.8 to −20.5)*
Percent Weight Loss	−6.5 ± 4.2 (0 to −18.9)*	−9.3 ± 5.0 (−2.2 to −22.6)*

approaches in weight management.

4.3. Conclusion

A clinical weight loss program with a flipped classroom pedagogy approach to health education proved feasible for delivery among adults with overweight/obesity and supported >9% weight loss after 6 months. Participants self-reported high enjoyment of the health education delivery style. The pedagogy approach supported high levels of diet adherence, increased MVPA, and attendance to health education sessions. Applying the flipped classroom in a clinical health program setting may serve as an effective strategy to promote long-term lifestyle change.

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CRediT authorship contribution statement

Kameron Suire: Writing – review & editing, Writing – original draft, Resources, Methodology, Investigation, Conceptualization. **Mary Hastert:** Writing – review & editing, Writing – original draft, Methodology, Investigation, Formal analysis, Data curation. **Stephen D. Herrmann:** Writing – review & editing, Writing – original draft, Supervision, Project administration, Methodology, Conceptualization. **Joseph E. Donnelly:** Writing – review & editing, Writing – original draft, Supervision, Project administration, Methodology, Conceptualization.

Declaration of competing interest

None.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.pecinn.2024.100308.

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