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Diet, physical activity, and health-related outcomes of endometrial cancer survivors in a behavioural lifestyle programme: the Diet and Exercise in Uterine Cancer Survivors (DEUS) parallel randomised controlled pilot trial

Abstract

Objectives

To explore the effectiveness of a theory-based behavioural lifestyle intervention on health behaviours and quality of life (QoL) in endometrial cancer survivors (ECS).

Methods/materials

This was a secondary analysis of a randomised controlled pilot trial conducted in two UK hospitals enrolling disease-free stage I-IVA ECS. Participants were allocated to an 8-week group-based healthy eating and physical activity intervention or usual care (UC) using 1:1 minimisation. Participants were followed up at 8- and 24-weeks, with the 8-week assessment being blinded. Diet, physical activity, and QoL were measured with the Alternative Healthy Eating Index 2010 (AHEI-2010), Stanford 7-Day Physical Activity Recall, and the EORTC-QLQ-C30, respectively. We analysed all eligible participants using the intention-to-treat approach in complete cases, adjusting for baseline values, body mass index, and age.

Results

We enrolled 60 of the 296 potentially eligible ECS (May - December 2015). Fifty-four eligible participants were randomised to the intervention (n=29) or UC (n=31), and 49 had complete follow-up data (n=24 in the intervention and n= 25 in UC). Intervention adherence was 77%. At 8-weeks, participants in the intervention improved their diet compared to UC (difference in AHEI-2010 score 7.5 (95% CI: 0.1, 14.9), p=0.046) but not their physical activity (0.1 MET-h/day 95% CI: (-1.6, 1.8), p=0.879), or global QoL score (5.0 (95% CI: -3.4, 13.3), p=0.236). Global QoL improved in intervention participants at 24-weeks (difference 8.9 (95% CI: 0.9, 16.8), p=0.029). No intervention-related adverse events were reported.

Conclusions

The potential effectiveness of the intervention appeared promising. A future fully-powered study is needed to confirm these findings.

Keywords

endometrial cancer, healthy eating, physical activity, quality of life

Trial registration

ClinicalTrials.gov identifier: NCT02433080, 20 April 2015

Trial URL: https://clinicaltrials.gov/ct2/show/NCT02433080

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Introduction

Endometrial cancer affects 9,000 UK women annually, most of whom (78%) will live more than ten years after diagnosis.[1] However, they are the long-term cancer group with the highest comorbidity burden post treatment[2] who are most likely to die from cardiovascular disease.[3] Moreover, the prevalence of obesity and suboptimal lifestyle behaviours is high, both of which are associated with lower health-related quality of life (HRQoL).[4] Thus, the effect of lifestyle changes on outcomes after endometrial cancer treatment has been identified as one of the 'top ten' endometrial cancer research priorities.[5] The early post treatment period is a key transition time during which women might be more motivated to engage in health behaviours but experience cancer-specific barriers to behaviour change.[6] Women also report a desire for in person advice[6] but that support is lacking post-treatment.[7]

Behavioural lifestyle interventions improve patient-reported outcomes, such as HRQoL, in people living with other forms of cancer[8, 9] and are also feasible for people after endometrial cancer treatment.[10, 11] We have previously adapted "Shape-Up", an evidence- and group-based behavioural lifestyle intervention[12] that is already running within the health care system, to the particular needs and preferences of this cancer group using patient input and a systematic framework.[13] We piloted the programme showing acceptable feasibility and high participant satisfaction.[14]

However, the potential effectiveness of such a programme is currently unclear. A recent meta-analysis including two randomised trials of lifestyle interventions and a single arm physical activity intervention showed mixed results for fatigue and global quality of life (QoL) in endometrial cancer survivors.[15] Thus, we performed a secondary analysis of our trial to explore its potential effectiveness for improving health behaviours, and HRQoL and report standard deviations for these outcomes to allow for sample size calculations for a fully-powered trial.[16]

Materials and Methods

Trial design

The trial protocol has been published.[17] The DEUS pilot trial was a parallel, randomised, controlled pilot trial with 1:1 allocation ratio to either the "Shape-Up following cancer treatment" intervention or care as usual. The CONSORT[18] and TIDieR[19] checklists are available as Supporting Information.

Participants and recruitment

Adult endometrial cancer (C54.1) survivors within three years of diagnosis were eligible to participate. Stage IVB cancer, active anti-cancer and/or palliative treatment, second primary cancer, lack of mental capacity to take part, severe depression, no availability for longitudinal follow-up, participation in a professionally delivered weight loss or exercise programme during the previous 6 months, performance score between 3-4[20], and inability to understand spoken and written English were the exclusion criteria. At the 5th week of recruitment, the inclusion criterion "women willing to attend all sessions" was removed given the subjective nature of its interpretation and the exclusion criterion "women with secondary cancer" was added to ensure homogeneity. Participants were recruited from two academic hospitals in London, UK between May and December 2015 and followed-up until June 2016; full details have been reported previously.[17]

Interventions

Shape-Up following cancer treatment

Intervention arm participants received the "Shape-Up following cancer treatment" manual and participated in eight group-based weekly 1.5-hour sessions on healthy eating and physical activity based on Social Cognitive Theory and Control Theory.[17] In brief, the sessions focused on establishing a regular eating pattern, getting a healthier balance of foods, keeping an eye on portion sizes, reducing sedentary activity, increasing lifestyle and organised activities, and managing triggers to unhealthy behaviours through behavioural self-monitoring and goal setting, problem solving, and self-incentives. The sessions took part at University College

London Hospitals NHS Trust. A trained research dietitian (DAK) facilitated the face-to-face group discussions following a standardised scripted manual. A second researcher was present in all but the last group for assistance, but did not participate in the discussion. The remaining delivery modifications included splitting the last group into two for convenience purposes, and participation of an additional survivor in one of those groups to enhance the group experience. The sessions were audio-recorded and a researcher (RJB) was present in one group session to assess fidelity based on a predefined checklist.

Care as usual

To match currently offered usual care, participants in this arm were contacted only for the study assessments. They received brief standardised information and a booklet with healthy lifestyle advice after study completion.[21]

Outcomes

Diet

The "Automated Self-Administered 24-Hour" (ASA24®) tool[22] was used for dietary assessment with a single weekday recall at each time point. Food records were transferred to the MRC Human Nutrition Unit's in-house dietary assessment software DINO (Diet In Nutrients Out) dietary assessment software[23] that incorporates the UK food composition database, given the country-specific food nutritional composition. Methodological details are provided in the supplementary material. An experienced independent data analyst scientist (NZ) guided the process and checked 10% of entries for accuracy.

The Alternative healthy eating index 2010 (AHEI-2010), which scores participants' diet against the recommended healthy eating patterns, was calculated on a scale of 0-110 with 110 indicating optimal diet. The score is based on 11 dietary components (vegetables, fruits, whole grains, sugar sweetened beverages, nuts and beans, red and processed meat, polyunsaturated fatty acids, long-chain omega-3 fatty acids, trans fatty acids, alcohol, salt), each contributing equally to the total score.[24]

Physical activity

Physical activity was assessed with a 15-minute interview using the reliable, valid, and responsive to change Stanford 7-Day Physical Activity Recall and was calculated using standardised methodology.[25, 26] At the 24-week follow-up, a subsample (n=28) also wore ActivPal™ (PAL Technologies Ltd, Glasgow, UK) accelerometers for seven consecutive days, including sleep, prior to the study assessment. Using waterproof adhesive dressing, participants attached the device to the middle of their right thigh following standardised guidelines. Data were exported from the ActivPal interface program.

Anthropometry, body composition, hand grip strength, and blood pressure

Weight (to the nearest 0.1kg) and body composition were measured with a multi-frequency segmental body composition analyser (MC-980, Tanita Corp., Tokyo, Japan). Body composition is automatically calculated from a proprietary prediction equation. To ensure stable subject conditions, participants were instructed to abstain from large meals or drinks two hours before the assessment. They emptied their bladder immediately before the assessment and cleaned their limbs with sanitiser to reduce oil and sweat, which can affect measurement accuracy. Measurements are missing for one participant who refused to remove her socks. Fat free mass index (FFMI) and fat mass index (FMI) were calculated based on the BMI formula (Supplementary material).

Using standardised protocols, height was measured with a stadiometer to the nearest 0.1cm and handgrip strength using a handgrip dynamometer (T.K.K.5401 grip – D, Takei Scientific Instruments, CO., LTD. Tokyo, Japan). Blood pressure was measured using an automated sphygmomanometer (Omron) with the participant seated comfortably for five minutes before measurement and their arm supported at the level of the heart. All measurements were taken twice and averaged for analysis.

Health-related quality of life (HRQoL) and health care resource use

Participants filled out the widely used, reliable, and validated EORTC QLQ-C30[27] and Endometrial Cancer Module (QLQ-EN24).[28] During the final follow-up assessment, participants completed a questionnaire on their health care resource use within the last six months.[29]

Sample size, randomisation, and blinding

With a significance level of 5%, 64 participants (32 per arm) were needed to assess the feasibility of the study regarding recruitment and adherence rate with 90% power and retention rate with 80% power.[17] The trial was not powered to detect differences in diet, physical activity, and health-related outcomes, and these analyses are therefore exploratory. The procedures for trial arm assignment and blinding have been followed without modification as detailed in the protocol.[17] In brief, participants were individually allocated to each arm with minimisation, using BMI and age as stratified variables. The researcher (MM) assessing the 8-week outcomes was blinded to arm allocation.

Statistical analysis

Following verification of assumptions (linearity, homogeneity of regression slopes, approximate normality of the residuals, homoscedasticity, and homogeneity of variances), analysis of covariance (ANCOVA) compared outcomes between the trial arms at 8-weeks (end of the active intervention) and at 24-weeks to explore longer term effects. Two models were run; an unadjusted and an adjusted one for BMI, age, and baseline values for the outcome of interest. The analysis followed the intention-to-treat strategy. Only eligible participants (n=54) were included in the complete case analysis following the recommendation of the Trial Steering Committee. The majority of missing data were due to non-attendance at follow-up. Group means are presented with standard deviations (SDs) and between group mean differences with 95% Cis. All analyses were carried out using the Statistical Package for Social Sciences (SPSS, Chicago, IL) version 23.

Results

Descriptive characteristics

Of the 296 potentially eligible participants, 20.3% (95% CI: 15.7, 24.9) enrolled in the study. Recruitment was terminated early due to resource constraints. Table 1 presents baseline participants' characteristics. At enrolment, the mean (± SD) age was 62.1 ± 8.3 years old, BMI 28.0 ± 6.3kg/m^2, and time since diagnosis 1.2 ± 1.0 years. More than half of participants were White (67%) and married (53%). The most common diagnosis was stage IA (49%), type 1 (82%) endometrial cancer. Twenty participants adhered to the intervention based on the pre-defined criteria.[17] The CONSORT diagram shows the trial progress (Figure 1).

Diet, physical activity, and self-efficacy

Changes by time and group are presented in Table 2 with ANCOVA statistics in Table S1. In the fully adjusted model, there was a significant improvement in the overall AHEI-2010 score in the active intervention group compared to control at 8-weeks (p=0.046) but not at 24-weeks (p=0.964). The relatively high self-efficacy score at baseline (Cronbach's alpha=0.77) did not change significantly between arms at follow-up.

Most participants (92.6%) were meeting the recommendations of at least 500 MET-minutes of moderate to vigorous physical activity at baseline. Furthermore, 31.5% were also meeting at least 500 MET-minutes of vigorous physical activity at baseline (Table S3). There was no evidence of a difference in the total energy expenditure or the energy expenditure from moderate to vigorous physical activities between groups at each time point.

Most participants performed minimal strength and flexibility exercises throughout the study (Table S4). The self-reported energy expenditure was significantly positively correlated both with estimated energy expenditure from the accelerometer (r_s=0.42, p=0.03) and with step count (r_s=0.49, p=0.008). However, the Bland-Altman analysis (n=28) suggested that the

questionnaire significantly overestimated total energy expenditure compared to the accelerometer (mean difference=0.8 MET/h, 95% CI: -3.0, 4.7, p=0.03).

Anthropometry, body composition, blood pressure, hand-grip strength

Only 24.1% of participants (19.2% and 28.6% in the active intervention and usual care arm, respectively) were affected by obesity based on BMI at baseline. There was a statistically significant reduction in weight at 8-weeks for those allocated to the intervention (p=0.007) but not at 24-weeks (p=0.196) in the adjusted model (Table 2). This observation was also evident for BMI. There was no evidence of significant changes in fat mass index or fat free mass index. The mean systolic blood pressure was higher than the ideal 120mmHg value at baseline in each arm. In contrast, the mean diastolic blood pressure and handgrip strength were normal. No evidence of statistically significant differences between arms was obtained for these physical measurements, apart from handgrip strength at 24-weeks (p=0.04).

HRQoL

Scores for HRQoL, function scales, and symptoms are presented in Table 3 for both arms with their changes at each time point. Overall, the baseline scores were high for the functional scales and low for symptoms, except for fatigue, insomnia, and muscular pain. In the adjusted model, there was a statistically significant difference in the global QoL between groups at 24-weeks (p=0.029) but not at 8-weeks (p=0.52). Those allocated to the intervention reported higher global QOL at 24-weeks compared those allocated to usual care. There was no evidence of a between group difference for the remaining HRQoL aspects, or symptoms, except constipation which improved significantly at 8-weeks for those allocated to the intervention arm (p=0.03) in the unadjusted model. Regarding the items specific to endometrial cancer, there was no observed significant change except a significant between-group improvement in the gastrointestinal symptoms at 8-weeks (p=0.02) in the unadjusted model (Table S5).

Health care resource use

Over the study period, participants reported a mean (SD) 1.4 (1.9) visits to their GP and 1.7 (1.6) visits to hospital outpatients, mainly in the oncology department. There were no hospital admissions or use of other health care services. They also reported taking on average (SD) 1.4 (1.9) medications at the last follow-up visit. No intervention-related adverse events were reported.

Discussion

This is the first study of a health behaviour change intervention in UK endometrial cancer survivors indicating potential effectiveness for behaviour change and patient-reported outcomes. In this exploratory analysis, overall diet improved at 8-weeks, while physical activity remained unchanged, and weight was statistically but not clinically significantly reduced. Despite the wide confidence intervals, global QoL improved significantly at 24-weeks, approaching clinical significance.[30]

Strengths of the study include the systematic development of the theory-based intervention with patient input,[13] use of a randomised design, validated outcome measures, masking of the 8-week assessor to intervention allocation, and medium-term follow-up. The intervention fits within the top ten research priorities for endometrial cancer research[5] and with the National Cancer Survivorship Initiative aim of delivering sustainable personalised lifestyle support to people with cancer.[31] Thus, a fully-powered trial should assess the potential impact of the intervention on the second NHS Outcome framework domain ("enhancing QoL for people with long term conditions").[32] We had an excellent retention rate (91%) compared with the 15-20% drop out typically seen in lifestyle trials at 6 months.[33]

Limitations of the study include the small sample size, lack of power, and presence of multiple testing that render the interpretation of all secondary outcomes as preliminary. However, the study provides a rich dataset for estimation of outcome measures for an efficacy trial. For example, a trial of 108 participants randomised 1:1 to the intervention or usual care would

provide definitive evidence of 12-point clinically significant improvement of global QoL assuming a standard deviation of 19, 90% power, and a=0.05. The definitive trial should also be powered for sustained behaviour change. Using the same assumptions, a total sample size of 98 participants would be needed to detect a clinically significant 10-point increase in the AHEI index (SD=15) and a sample of 120 to detect an increase of 30 minutes in weekly moderate to vigorous physical activity using accelerometry (SD=50).

The 24-week assessment was unblinded and contamination of the control group has been reported.[14] Both physical activity and dietary data were self-reported. Using objective physical activity measurements in future trials would avoid the substantial overestimation of self-reported physical activity. The single weekday 24-hour recall could not account for day-to-day variations in dietary intake but was sufficient to determine between group differences.[34] Diet was comprehensively assessed with AHEI-2010, which strongly predicts survival[24] and its components were targeted with the intervention. Although bioelectrical impedance falls behind other techniques in accuracy, it still provides a practical, non-invasive and reliable method for body composition estimation. Furthermore, relatively high levels of health behaviours, HRQoL and functioning were reported at baseline, which limits the generalisability of the findings and could hinder future studies with similar samples from observing differences due to ceiling effects. Hence, future studies should consider the implementation of potential entry cut-offs for HRQoL, functioning, and behavioural measures. Limited evidence suggests these ceiling effects might be less common in the FACT-G, which may also have stronger reliability and validity compared with the EORTC-QLQ-C30.[35] Thus, future trials should consider using multiple instruments to assess HRQoL.

Baseline AHEI-2010 scores were comparable to those of a UK population-based study using the early AHEI version that indicated a negative association between AHEI adherence and mortality.[36] Previous studies in endometrial cancer survivors have mainly assessed fruit and vegetable intake as a dietary quality proxy, with similar[37] or higher[11] scores for fruit and vegetables. However, this approach fails to comprehensively assess various dietary

constituents that can affect disease risk. Therefore, future dietary assessment should consider an overall dietary approach.

The significant improvement in overall diet at 8-week follow-up within the intervention arm, indicates the potential effectiveness of “Shape-Up following cancer treatment”. However, diet seemed to decline at 24-weeks indicating that a behavioural maintenance programme may be required. Such a programme could include similar behaviour change techniques to those included within the current intervention.[38] The lack of change in PA, while potentially attributable to ceiling effects, could also indicate that this aspect of the programme would benefit from greater input. In line with this, we have previously reported that participants in the programme suggested additions to the programme focusing on PA would be beneficial.[14]

As the intervention promoted healthy eating and physical activity for overall health but not for weight loss, the combined lack of calorie restriction advice and high prevalence of participants with normal weight probably accounted for the lack of clinically significant weight loss. However, the demonstrated weight change provides confidence that the programme could promote avoidance of weight gain and acts as a surrogate marker of programme adherence. Furthermore, clinically significant weight loss might not be necessary for health benefits provided there is sustained practice of health behaviours.[39]

While mostly not significant, mean differences for various HRQoL outcomes between the active intervention and control arms generally trended towards the expected direction, and those allocated to the intervention reported higher global QOL at 24 weeks compared those allocated to usual care. Our data are in line with the SUCCEED lifestyle weight loss trial showing significant improvements in fatigue and physical function between groups and in total QoL score within the lifestyle intervention.

In the mission of survivorship advancement through lifestyle, health care professionals can play an integral role. Provision of brief lifestyle advice to endometrial cancer survivors after treatment and directing them to relevant resources may help facilitate lifestyle changes, as

survivors report being more likely to engage in behaviour change following counselling from their oncologist.[40] Given the time constraints during clinical appointments, interventions training health care professionals to deliver very brief lifestyle advice and motivate survivors appear feasible and acceptable.[41] Combining these interventions with the current one may increase intervention efficacy.

Conclusion

In conclusion, the self-help group intervention showed promising effectiveness. Further consideration should be given to improving the physical activity component and behaviour maintenance aspects of the intervention. A large-scale evaluation of the intervention could inform whether it will help endometrial cancer survivors improve their health behaviours and, subsequently, well-being, and whether it has the potential to minimise health care costs.

References

[1] Quaresma M, Coleman MP, Rachet B. 40-year trends in an index of survival for all cancers combined and survival adjusted for age and sex for each cancer in England and Wales, 1971-2011: a population-based study. Lancet. 2015;**385**: 1206-18.

[2] Leach CR, Weaver KE, Aziz NM et al. The complex health profile of long-term cancer survivors: prevalence and predictors of comorbid conditions. Journal of cancer survivorship : research and practice. 2015;**9**: 239-51.

[3] Ward KK, Shah NR, Saenz CC et al. Cardiovascular disease is the leading cause of death among endometrial cancer patients. Gynecologic oncology. 2012;**126**: 176-9.

[4] Koutoukidis DA, Knobf MT, Lanceley A. Obesity, diet, physical activity, and health-related quality of life in endometrial cancer survivors. Nutrition reviews. 2015;**73**: 399-408.

[5] Wan YL, Beverley-Stevenson R, Carlisle D et al. Working together to shape the endometrial cancer research agenda: The top ten unanswered research questions. Gynecologic oncology. 2016;**143**: 287-93.

[6] Koutoukidis DA, Beeken RJ, Lopes S et al. Attitudes, challenges, and needs about diet and physical activity in endometrial cancer survivors: a qualitative study. European journal of cancer care. 2016.

[7] PHE. Living with and beyond womb cancer: A descriptive summary of responses to a pilot of Patient Reported Outcome Measures for gynaecological cancer. London: Public Health England 2015.

[8] Stacey FG, James EL, Chapman K et al. A systematic review and meta-analysis of social cognitive theory-based physical activity and/or nutrition behavior change interventions for cancer survivors. Journal of cancer survivorship : research and practice. 2014.

[9] Morey MC, Snyder DC, Sloane R et al. Effects of home-based diet and exercise on functional outcomes among older, overweight long-term cancer survivors: RENEW: a randomized controlled trial. JAMA : the journal of the American Medical Association. 2009;**301**: 1883-91.

[10] von Gruenigen VE, Gibbons HE, Kavanagh MB et al. A randomized trial of a lifestyle intervention in obese endometrial cancer survivors: quality of life outcomes and mediators of behavior change. Health Qual Life Outcomes. 2009;**7**: 17.

[11] von Gruenigen V, Frasure H, Kavanagh MB et al. Survivors of uterine cancer empowered by exercise and healthy diet (SUCCEED): a randomized controlled trial. Gynecologic oncology. 2012;**125**: 699-704.

[12] Wardle J, Liao LM, Rapoport L et al. Shape-Up: A lifestyle programme to manage your weight. London: Weight Concern 2016.

[13] Koutoukidis DA, Lopes S, Croker H et al. Use of intervention mapping to adapt a health behavior change intervention for endometrial cancer survivors: the Shape-Up following cancer treatment program. BMC public health. 2016;**In Press**.

[14] Koutoukidis DA, Beeken RJ, Manchanda R et al. Recruitment, adherence, and retention of endometrial cancer survivors in a behavioural lifestyle programme: the Diet and Exercise in Uterine Cancer Survivors (DEUS) parallel randomised pilot trial. BMJ open. 2017;**7**: e018015.

[15] Smits A, Lopes A, Das N et al. The effect of lifestyle interventions on the quality of life of gynaecological cancer survivors: A systematic review and meta-analysis. Gynecologic oncology. 2015;**139**: 546-52.

[16] Teare MD, Dimairo M, Shephard N et al. Sample size requirements to estimate key design parameters from external pilot randomised controlled trials: a simulation study. Trials. 2014;**15**: 264.

[17] Koutoukidis DA, Beeken RJ, Manchanda R et al. Diet and exercise in uterine cancer survivors (DEUS pilot) - piloting a healthy eating and physical activity program: study protocol for a randomized controlled trial. Trials. 2016;**17**: 130.

[18] Eldridge SM, Chan CL, Campbell MJ et al. CONSORT 2010 statement: extension to randomised pilot and feasibility trials. Pilot Feasibility Stud. 2016;**2**: 64.

[19] Hoffmann TC, Glasziou PP, Boutron I et al. Better reporting of interventions: template for intervention description and replication (TIDieR) checklist and guide. BMJ. 2014;**348**: g1687.

[20] Oken MM, Creech RH, Tormey DC et al. Toxicity and response criteria of the Eastern Cooperative Oncology Group. Am J Clin Oncol. 1982;**5**: 649-55.
[21] WCRF. Healthy living after cancer. World Cancer Research Fund 2015.
[22] Subar AF, Kirkpatrick SI, Mittl B et al. The Automated Self-Administered 24-hour dietary recall (ASA24): a resource for researchers, clinicians, and educators from the National Cancer Institute. Journal of the Academy of Nutrition and Dietetics. 2012;**112**: 1134-7.
[23] Fitt E, Cole D, Ziauddeen N et al. DINO (Diet In Nutrients Out) - an integrated dietary assessment system. Public health nutrition. 2015;**18**: 234-41.
[24] Chiuve SE, Fung TT, Rimm EB et al. Alternative dietary indices both strongly predict risk of chronic disease. The Journal of nutrition. 2012;**142**: 1009-18.
[25] Sallis JF, Haskell WL, Wood PD et al. Physical activity assessment methodology in the Five-City Project. American journal of epidemiology. 1985;**121**: 91-106.
[26] Bonnefoy M, Normand S, Pachiaudi C et al. Simultaneous validation of ten physical activity questionnaires in older men: a doubly labeled water study. Journal of the American Geriatrics Society. 2001;**49**: 28-35.
[27] Aaronson NK, Ahmedzai S, Bergman B et al. The European Organization for Research and Treatment of Cancer QLQ-C30: a quality-of-life instrument for use in international clinical trials in oncology. Journal of the National Cancer Institute. 1993;**85**: 365-76.
[28] Greimel E, Nordin A, Lanceley A et al. Psychometric validation of the European Organisation for Research and Treatment of Cancer Quality of Life Questionnaire-Endometrial Cancer Module (EORTC QLQ-EN24). European journal of cancer. 2011;**47**: 183-90.
[29] Gordon LG, Patrao T, Hawkes AL. Can colorectal cancer survivors recall their medications and doctor visits reliably? BMC health services research. 2012;**12**: 440.
[30] Osoba D, Rodrigues G, Myles J et al. Interpreting the significance of changes in health-related quality-of-life scores. Journal of clinical oncology : official journal of the American Society of Clinical Oncology. 1998;**16**: 139-44.
[31] DoH. National Cancer Survivorship Initiative Vision. In: Department of Health MCSNI, ed. London: Department of Health, Macmillan Cancer Support & NHS Improvement 2010.
[32] DoH. The NHS Outcomes Framework 2015/16. In: NHS Group DoHF-N-N-, ed. London: NHS Group, Department of Health FN-NHSG-NHSCPS-17185 2014.
[33] Ahern AL, Wheeler GM, Aveyard P et al. Extended and standard duration weight-loss programme referrals for adults in primary care (WRAP): a randomised controlled trial. Lancet. 2017;**389**: 2214-25.
[34] NCI. Dietary Assessment Primer, Summary Tables: Recommendations on Potential Approaches to Dietary Assessment for Different Research Objectives Requiring Group-level Estimates. In: National Institutes of Health NCI, ed.: National Institutes of Health, National Cancer Institute 2016.
[35] Luckett T, King MT, Butow PN et al. Choosing between the EORTC QLQ-C30 and FACT-G for measuring health-related quality of life in cancer clinical research: issues, evidence and recommendations. Annals of oncology : official journal of the European Society for Medical Oncology / ESMO. 2011;**22**: 2179-90.
[36] Akbaraly TN, Ferrie JE, Berr C et al. Alternative Healthy Eating Index and mortality over 18 y of follow-up: results from the Whitehall II cohort. The American journal of clinical nutrition. 2011;**94**: 247-53.
[37] Blanchard CM, Courneya KS, Stein K. Cancer survivors' adherence to lifestyle behavior recommendations and associations with health-related quality of life: results from the American Cancer Society's SCS-II. Journal of clinical oncology : official journal of the American Society of Clinical Oncology. 2008;**26**: 2198-204.
[38] Teixeira PJ, Carraca EV, Marques MM et al. Successful behavior change in obesity interventions in adults: a systematic review of self-regulation mediators. BMC Med. 2015;**13**: 84.
[39] Estruch R, Martinez-Gonzalez MA, Corella D et al. Effect of a high-fat Mediterranean diet on bodyweight and waist circumference: a prespecified secondary outcomes analysis of the PREDIMED randomised controlled trial. The lancet Diabetes & endocrinology. 2016.

[40] Zaleta AK, Neff R, McCann GA et al. Perceptions of weight management counseling among gynecologic cancer survivors: opportunities for enhancing survivorship care. Support Care Cancer. 2017;**25**: 1537-45.
[41] Webb J, Hall J, Hall K, Fabunmi-Alade R. Increasing the frequency of physical activity very brief advice by nurses to cancer patients. A mixed methods feasibility study of a training intervention. Public Health. 2016.

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Conflict of Interest Statement

DAK and RJB are volunteers for the charity Weight Concern, which developed the "Shape-Up" programme for the general population. All other authors have no conflicts of interest to declare.

Contribution to Authorship

The authors' contributions were as follows. AL and MTK conceived the study and were the grant holders. AL and RM were the site investigators for University College London Hospitals and Barts Health, respectively. DAK, AL, RJB and MTK initiated the study design, and RM

helped with protocol development and implementation. DAK and MM recruited the study participants. RJB was responsible for randomization and auditing. DAK was the trial manager, ran the group sessions, and conducted the baseline and 24-week follow-up assessments. MM conducted the 8-week follow-up assessments. NZ guided the dietary data analysis and checked entries for accuracy. MB provided the statistical support, and DAK conducted the statistical analysis. DAK drafted the manuscript, which was amended following comments from all other authors. All authors read and approved the submitted manuscript. All listed authors meet the criteria for authorship and no individual meeting these criteria has been omitted.

Details of ethics approval

The study protocol and documents have been reviewed and approved by the relevant sponsor and National Research Ethics Service Committee London - City Road and Hampstead (Reference: 15/LO/0154, 17 March 2015).