

# Moderators of intervention dose effects on diet quality and physical activity changes in a church-based, multicomponent, lifestyle study: Delta Body and Soul III

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## Abstract

Many community-based lifestyle interventions targeting African Americans have reported positive effects on participants' dietary choices and physical activity habits. However, these effects vary and not all participants will have outcome changes. Moderation analysis can help explain differential effects observed, but are not often reported. Hence, the objective of this secondary analysis was to explore potential moderators of intervention dose effects on diet quality and physical activity outcomes in an effective lifestyle intervention. Delta Body and Soul III, conducted from 2011 to 2012, was a 6-month, church-based, multicomponent, educational intervention designed to improve diet quality and increase physical activity in rural Southern African American adults. Generalized linear mixed models were used to determine associations among indicators of intervention dose received by participants, potential moderators and health outcome changes. Results indicated only three baseline characteristics—employment status, food shopping frequency and individual with primary responsibility for meal preparation—moderated the effects of education session attendance on diet quality changes. No evidence for moderation of exercise class attendance effects on physical

activity changes was found. Thus, this culturally targeted, multicomponent lifestyle intervention did induce positive health changes in participants with a range of sociodemographic characteristics and food shopping and eating behaviors.

## Introduction

Adverse effects of obesity on chronic diseases with high prevalence and high burden are well documented [1]. Lifestyle changes, such as eating a balanced diet and accumulating adequate amounts of physical activity, can control and even reverse obesity, type 2 diabetes, hypertension and hyperlipidemia. This may be particularly relevant for minority and other at risk populations who are disproportionately affected by these chronic diseases. However, lifestyle interventions proven effective in one population are not necessarily effective in different populations. Hence, the modification or targeting of effective diet and physical activity interventions is often necessary to fit specific strengths, needs and barriers of other populations, such as African American communities [2, 3].

In the past decade, a multitude of community-based lifestyle interventions designed for African Americans have been conducted and most have reported positive effects on participants' dietary

choices and physical activity habits [4]. Churches play an important role in rural communities, serving as primary organizational units and sources of social support and leadership [5]. As such, they are potentially effective settings for implementing health interventions [6, 7]. Body and Soul is a church-based intervention that successfully combined ecological and individual level approaches to increase fruit and vegetable intake among African Americans through their churches [8]. Seeking to build upon and expand Body and Soul's success, an adapted version of this intervention, Delta Body and Soul, was designed, implemented and proven effective for improving diet quality and increasing physical activity in rural Southern African American adults [9–11]. A secondary analysis revealed that observed changes in health outcomes were largely driven by level of participant engagement in components of the intervention, specifically education session attendance (EDA) [12]. The comparatively weak associations between exercise class attendance (EXA) and physical activity changes suggested that moderation analysis might reveal more complex relationships among participants' baseline characteristics, levels of engagement and changes in health outcomes. Others also have called for examination of intragroup differences that may influence intervention efficacy [2]. Identifying participant characteristics that moderate intervention effects is important as such analyses may help explain any differential effects observed and specify for whom and when a treatment will be effective [13]. Irrespective of this call to action, little has been reported in the literature regarding moderation of the effects of educational components in health interventions. For these reasons, the objective of the current secondary analysis was to explore potential effect moderators of intervention dose on diet quality and physical activity outcomes in Delta Body and Soul III.

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## Methods

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### Ethics approval

Procedures followed in Delta Body and Soul III were in accordance with ethical standards for

human research, and approval was obtained from the Institutional Review Board of Delta State University, Cleveland, MS. Study participants provided informed written consent.

### Design, setting and recruitment

This 6-month, church-based, multicomponent educational intervention was designed to improve diet quality and increase physical activity in rural Southern African American adults. Church recruitment across four contiguous United States Lower Mississippi Delta counties occurred via mailed study invitation letters to churches identified by research staff indigenous to the region, followed by telephone contact to schedule an informational study presentation. Churches qualified for study participation if able to preregister at least 20 eligible congregational members. Religious denomination was not an inclusion or exclusion criterion. Church committees, composed of the pastor, his wife and one to three church members, were responsible for recruiting participants from their church. Individual participant eligibility criteria included at least 18 years of age and not currently pregnant. Additionally, participants with baseline blood pressures >160/110 mm Hg or resting heart rates >110 beats/min were required to obtain written medical clearance before being allowed to join the exercise classes.

Of the nine churches contacted, the first five churches were assigned to the intervention group ( $n = 287$  participants), the last three to the control group ( $n = 122$  participants) and one declined to participate. Assigning more churches to intervention increased the statistical power for detecting changes within this group as previous experience showed more variability within the intervention group as compared with the control group [14]. Church enrollment occurred on a rolling basis with baseline data collected between August and October 2011 and post-intervention data between March and May 2012. This study's CONSORT diagram has been previously reported in reference [12].

## Intervention

Delta Body and Soul III was an adaptation of the original theory- and evidence-based Body and Soul program [8] and built upon two earlier lower dose intensity interventions also conducted in the Lower Mississippi Delta [10, 11]. Similar to the underlying theory guiding the development, implementation and evaluation of the original Body and Soul program, this study targeted the psychosocial constructs from the Transtheoretical Model of Behavioral Change (decisional balance and self-efficacy) [15] and the construct of social support [16]. For this study, higher intensity modifications included replacing peer counseling with counseling by trained research staff (telephone motivational interviewing; up to two calls), broadening the dietary focus, adding three more nutrition education sessions, adding one didactic physical activity education session and including approximately weekly supervised physical activity classes ( $n = 20$ ).

The 60-min education sessions consisted of a total of nine sessions—eight focused on nutrition and one focused on physical activity. These education sessions were held approximately every 3 weeks and emphasized increasing consumption of fruits, vegetables, whole grains and low-fat dairy foods; decreasing consumption of solid fats, added sugars and sodium; eating a healthy breakfast; meal planning and healthy food substitutions, including regional and cultural foods; weight and portion control; reading food labels; and childhood obesity. Presentations and activities (e.g. cooking demonstrations) were developed by the research staff and delivered collaboratively with a trained church liaison who also called participants to remind them of upcoming sessions. Healthful foods and beverages consistent with lesson themes were served at these events. The single didactic physical activity session was centered on the benefit of, recommendations for and strategies for overcoming barriers to physical activity. A trained, certified fitness instructor co-led this session and taught the 60-min supervised physical activity classes, which incorporated approximately equal proportions of aerobic and strength/flexibility activities. All study-related

events were held at the churches, except in the case of the smallest church for which a nearby US Department of Agriculture facility was used. Further details regarding the training of church liaisons and intervention components are published elsewhere [9].

Intervention participants received binders consisting of the nine educational lessons, healthy recipes and other nutrition, chronic disease prevention and physical activity related handouts. Intervention participants also received a Delta Body and Soul cookbook and monthly newsletters that featured nutrition and physical activity topics, healthy recipes and dates and times for upcoming education sessions and exercise classes. Additionally, intervention participants had access to their church's health and fitness station, which consisted of a digital scale, digital blood pressure monitor, body mass index (BMI) and blood pressure monitoring charts, culturally appropriate fitness DVD library, and television with built in DVD player. These stations were given to the intervention churches as participation incentives. However, use of these stations was not monitored by research staff. The cultural targeting of the intervention involved surface structure to increase the receptivity, comprehension and acceptance of the health messages delivered [17].

Participants in the control churches received bi-monthly newsletters containing information pertaining to cold and influenza, food safety and minimizing stress. To compensate time for data collection procedures, \$30 gift cards were provided to participants at baseline and post-intervention time points. Further details regarding study methodology are published elsewhere [9].

## Measures

Surveys were interviewer administered and data included demographic characteristics, self-report medical diagnoses, medications, smoking and food shopping and eating behaviors. The food shopping and eating behavior questions were taken from the National Cancer Institute's Food Attitudes and Behaviors Survey ( $n = 5$  items) [18] or were created based upon current research about factors that may

affect an individual's diet (e.g. frequency of eating breakfast and frequency of meals cooked at home;  $n = 5$  items).

Dietary intake for the previous 6 months was measured using the Delta Food Frequency Questionnaire (Delta FFQ) [19]. The Delta FFQ data were used to generate Healthy Eating Index-2005 (HEI-2005) total and component scores. The HEI-2005 measures adherence to the 2005 Dietary Guidelines for Americans (2005 DGA). The 12 components of HEI-2005 are summed to create a total score with a maximum value of 100 [20]. For each component, higher scores reflect better adherence to the 2005 DGA recommendations. Only valid ( $\leq 5$  missing questionnaire items) and plausible (daily intake between 500 and 6000 kcal) Delta FFQs were used in the analyses (96% of intervention participant FFQs).

Physical activity was measured using the Rapid Assessment of Physical Activity (RAPA) [21] that classifies aerobic physical activity into one of five categories—sedentary, underactive, underactive regular light, underactive regular and active. Anything less than active is considered suboptimal. The RAPA also classifies strength and flexibility physical activity into one of four categories—none, strength only, flexibility only and both strength and flexibility.

Anthropometric variables included height, measured using a vertical stadiometer (Shorr Production, Olney, MD) and weight, measured using a calibrated digital scale (model BWB-500, Tanita Corp., Tokyo, Japan). BMI was calculated as weight (kg) divided by height (meters) squared. Details regarding other (e.g. clinical) study measures that were not used in the current analyses can be found elsewhere [9]. To track EDA and EXA, participants signed in upon arrival at these events. These two measures were used to assess intervention dose received by participants.

## Analyses

Statistical analyses were performed using SAS software, version 9.4 (SAS Institute Inc., Cary, NC). Because the objective of these analyses was to

explore potential moderators of the effects between intervention dose received and health outcome changes, only data from the intervention group was used. Generalized linear mixed models were used to determine associations among indicators of intervention dose received by participants (EDA and EXA), potential effect moderators and health outcome (6-month) changes (baseline to post-intervention). Diet quality changes were modeled using a Gaussian distribution with the identity link. Physical activity changes were modeled using a multinomial distribution with the cumulative logit link. Maximum likelihood estimation was used with church modeled as a repeated (fixed) effect using variance components covariance matrix structure. The PROCESS macro, version 2.12.2 [22] was used to compute significance regions for differing levels of the moderator variables using the Johnson-Neyman technique [23].

Covariates and potential moderators of intervention dose effects included baseline outcome value of interest (e.g. baseline diet quality score), gender, age, marital status [married (including common law) or not married (widowed, separated, divorced and never married)], education [less than or equal to high school [including general equivalency diploma (GED)] or greater than high school (some college, vocational/technical degree and associate's degree or higher)], employment status [not employed (unemployed, retired, student and disabled) or employed (full time, part time and self-employed)], vehicle ownership (yes or no), perceived weight status (healthy weight, overweight or obese), self-reported health (poor/fair or good/excellent), individual in household with primary responsibility for food shopping (self or other), individual in household with primary responsibility for meal preparation (self or other), frequency of food shopping (weekly or monthly), frequency of home cooked meals (0–2, 3–4 or 5–7 times/week), frequency of breakfast consumption (0–2, 3–4 or 5–7 times/week), frequency of fast food consumption (0–2, 3–4 or 5–7 times/week) and frequency of eating together (0–2, 3–4 or 5–7 times/week). Due to the lack of theoretical postulation, subject matter expertise and empirical knowledge from past interventions

in this region were used to guide moderator variable selection. All variables were considered as potential moderators except baseline outcome values, which were modeled as covariates due to their relatively strong association with outcome changes. Models were first run separately for each individual moderator and outcome of interest. Subsequently, all significant moderators and baseline outcome values were included in a single model for each outcome of interest with stepwise selection used, if warranted, until only significant effects remained.

Health outcomes included the diet quality and physical activity measures with significant change post-intervention. For diet quality, these measures included the HEI-2005 total score and five component scores—total fruit; whole fruit; total vegetables; dark green and orange vegetables and legumes (DGOV&L); and solid fats, alcoholic beverages and added sugars (SoFAAS). The physical activity outcome consisted of strength/flexibility physical activity with change modeled in categorical form—decrease, no change (including switch from strength to flexibility and vice versa) or increase. Because moderation of EXA by eating and food shopping behaviors did not make sense conceptually, these interactions were not tested in the physical activity models. Group comparisons for the categorical variables were based upon least squares means with Tukey-Kramer adjusted *P*-values used for multiple comparisons. Non-standardized regression coefficients were reported. The significance level of the tests was set at 0.05.

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## Results

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The retention rate for the intervention group was 76% (219/287). Table I shows that the majority of intervention participants were female, did not smoke, owned a vehicle and had primary responsibility for household food shopping and meal preparation. Mean BMI was 35 kg/m<sup>2</sup> and mean age was 47 years. Nineteen (7%) intervention participants were ineligible to partake in the exercise classes due to their failure to obtain medical clearance and hence were excluded from the physical activity analyses.

### Associations between diet quality and physical activity outcome changes and intervention dose effects

Table II presents the diet quality components with significant mean changes from baseline to post-intervention and their associations with EDA for intervention participants. Significant improvements were observed in total fruit, whole fruit, total vegetables, DGOV&L, SoFAAS and total diet quality (mean change = 0.4–4.0 points). Significant associations (correlation coefficients = 0.1–0.3) between changes in these diet quality components and EDA were apparent for all except total fruit and DGOV&L. In terms of strength/flexibility physical activity, significantly more intervention participants reported an increase in strength/flexibility activity as compared with those who reported a decrease in activity (30 versus 11%, respectively; *p* < 0.001). A significant association was not found between change in strength/flexibility physical activity and EXA (Spearman correlation coefficient = 0.13, *P* = 0.065).

### Moderation of intervention dose effects on diet quality and physical activity outcome changes by participant baseline characteristics

Employment status was one of two moderators of the relationship between EDA and change in total vegetables diet quality such that the effect was larger for participants who were not employed versus employed participants. As illustrated in Figure 1, for employed participants, effects ranged from a small decrease in diet quality at low EDA values to almost a one-point increase at high EDA values. For participants who were not employed, effects ranged from a decrease in diet quality for low EDA values to more than a 1.5-point increase at high EDA values. At EDA values < 1.5, changes in total vegetables diet quality differed significantly between participant subgroups.

Responsibility for meal preparation was the second moderator of the relationship between EDA and changes in total vegetables diet quality such that significance was observed only for

**Table I.** Baseline characteristics for intervention participants: Delta Body and Soul III, MS, 2011–2012

Characteristic	Scale Range	(n = 287)	
		n	%
Female		216	75.3
African American <sup>a</sup>		282	98.3
Married/living with significant other <sup>b</sup>		129	45.1
> High school education		163	56.8
Employed <sup>c</sup>		154	54.6
Have health insurance		196	72.3
Own vehicle		235	81.9
Smoker		40	13.9
Chronic health condition			
Diabetes		59	21.3
Hypertension		154	54.0
High cholesterol		63	22.3
Perceived weight status			
Healthy weight		84	29.5
Overweight		174	61.1
Obese		27	9.5
Poor/fair self-reported health <sup>d</sup>		122	43.0
Household food shopper <sup>e</sup>		205	73.0
Household meal preparer <sup>e</sup>		190	68.8
Weekly food shopping <sup>f</sup>		124	43.7
Frequency of home cooked meals			
0–2 times/week		51	17.8
3–4 times/week		101	35.3
5–7 times/week		134	46.9
Frequency of eating breakfast			
0–2 times/week		108	37.9
3–4 times/week		48	16.8
5–7 times/week		129	45.3
Frequency of eating fast food			
0–2 times/week		196	70.3
3–4 times/week		55	19.7
5–7 times/week		28	10.0
Frequency of eating together			
0–2 times/week		122	43.4
3–4 times/week		66	23.5
5–7 times/week		93	33.1
Some strength/flexibility PA		105	37.5
		Mean	SD
Age (years)		47.3	14.43
BMI (kg/m <sup>2</sup> )		34.5	8.33
HEI 2005			
Total fruit	0–5	2.4	1.49
Whole fruit	0–5	2.4	1.53
Total vegetables	0–5	3.2	1.29
DGOV&L	0–5	2.4	1.52
Whole grain	0–5	2.0	1.66

(continued)

**Table I. Continued**

Characteristic	Scale Range	(n = 287)	
		n	%
SoFAAS	0–20	12.1	4.50
Total diet quality	0–100	55.8	10.16

SD, standard deviation; PA, physical activity; DGOV&L, dark green and orange vegetables and legumes; SoFAAS, solid fats, alcoholic beverages, and added sugars.

<sup>a</sup>Other category included white, Hispanic, other and multiracial.

<sup>b</sup>Not married category included never married, widowed, divorced or separated.

<sup>c</sup>Employed category included full time, part time and self-employed; unemployed category included unemployed, retired, student and disabled.

<sup>d</sup>Other category included good and excellent.

<sup>e</sup>Other category included significant other/spouse, mother, father, grandmother, grandfather, other female, other male and other.

<sup>f</sup>Weekly category included 1, 3–4, 5–6, and 7 days/week; monthly category included <1, 1 and 2–3 times per month.

**Table II.** Diet quality components with significant changes post-intervention and associations with EDA: Delta Body and Soul III, MS, 2011–2012

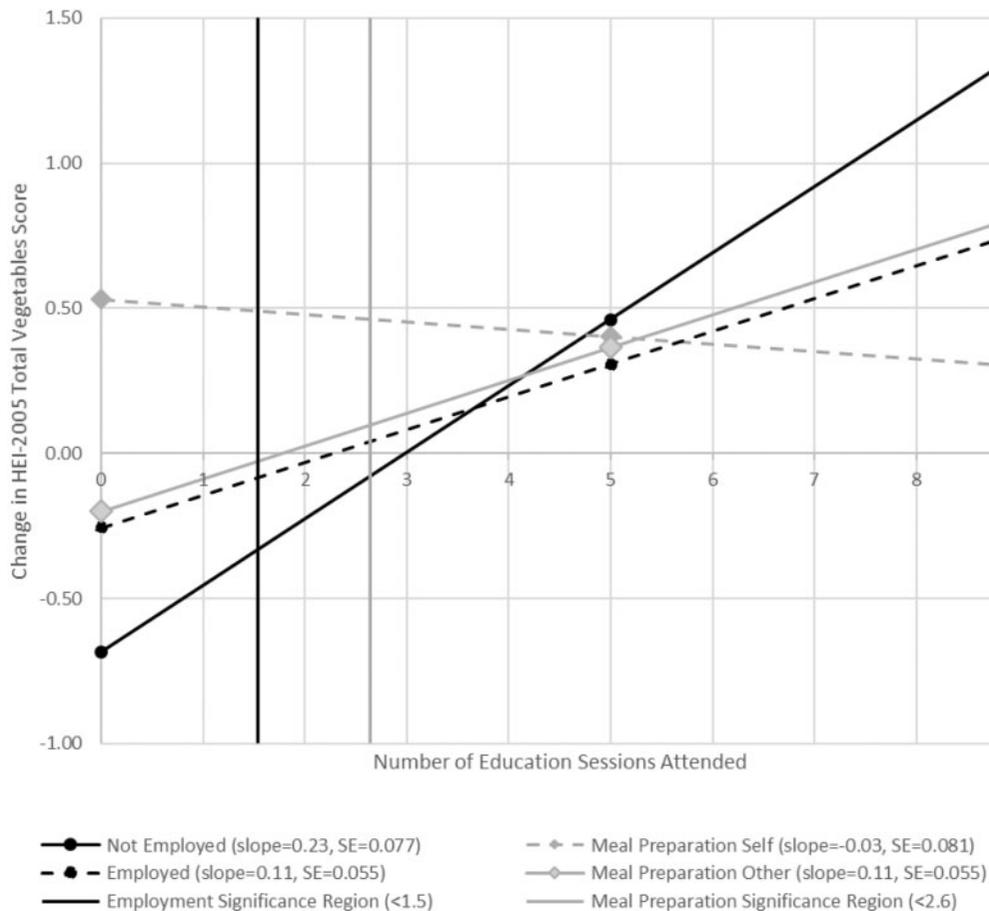
HEI 2005	Change <sup>a</sup>		Association	
	LSM	SEM	r <sup>b</sup>	P
Total fruit	0.5	0.15	0.03	0.695
Whole fruit	0.5	0.19	0.14	0.047
Total vegetables	0.4	0.12	0.21	0.004
DGOV&L	0.6	0.17	0.05	0.528
SoFAAS	1.3	0.49	0.22	0.002
Total diet quality	4.0	0.93	0.28	<0.001

LSM, least squares mean; SEM, standard error of mean; DGOV&L, dark green and orange vegetables and legumes; SoFAAS, solid fats, alcoholic beverages and added sugars.

<sup>a</sup>Change from post-intervention to baseline; significant at the 0.05 level.

<sup>b</sup>Pearson correlation coefficients for association between EDA and diet quality component.

participants living in households in which others had primary responsibility for meal preparation as compared with participants living in households in which they themselves had this responsibility. As illustrated in Figure 1, participants with primary responsibility for meal preparation had an approximate 0.4-point increase across the range of EDA values, while those living in households in which



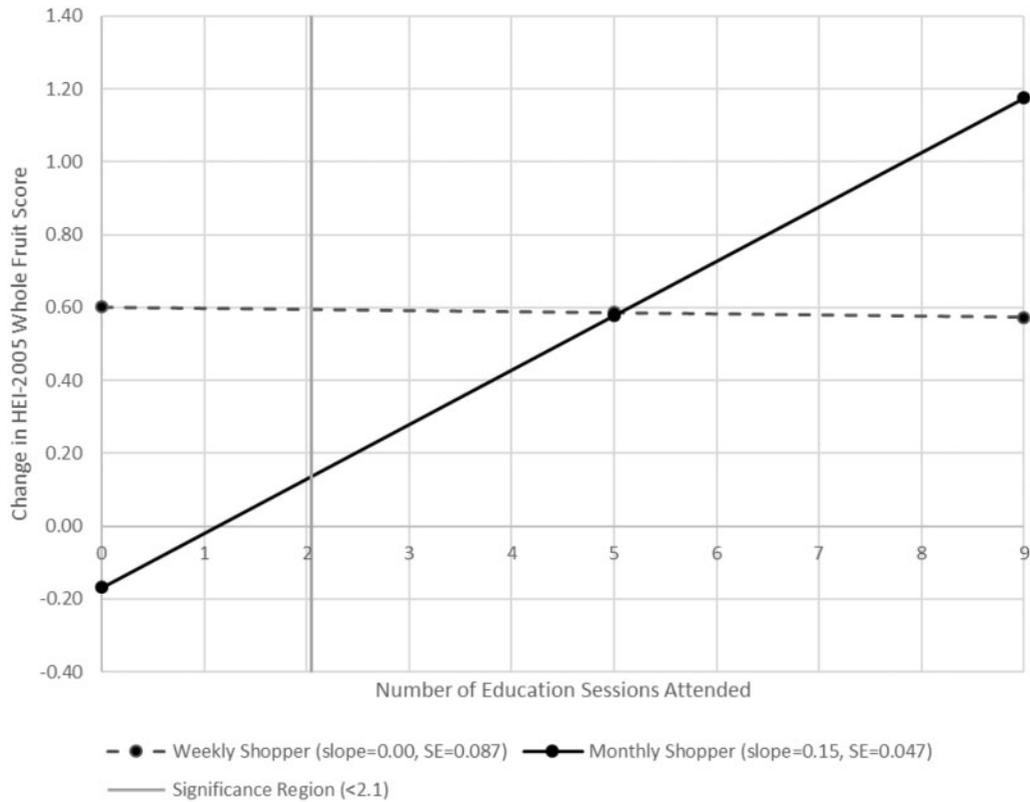
**Fig. 1.** Moderation of EDA effects on change in total vegetables diet quality by employment status and individual with primary responsibility for meal preparation.

others had primary responsibility rose from a small decrease to almost a one-point increase in diet quality. At EDA values  $<2.6$ , changes in total vegetables diet quality differed significantly between participant subgroups.

Frequency of food shopping was the only moderator of the relationship between EDA and changes in whole fruit diet quality such that significance was observed only in participants shopping on a monthly versus weekly basis. As illustrated in Figure 2, participants who shopped weekly had a consistent 0.6-point increase across the range of EDA values, while those who shopped monthly rose from a small

decrease in diet quality for low EDA values to over a one-point increase at high EDA values. At EDA values  $<2.1$ , changes in whole fruit diet quality differed significantly between participant subgroups.

Responsibility for meal preparation lost significance ( $P = 0.075$ ) as a moderator of the relationship between EDA and changes in DGOV&L diet quality once baseline DGOV&L scores were included in the model. Similarly, frequency of breakfast consumption lost significance ( $P = 0.194$ ) as a moderator of the relationship between EDA and changes in SoFAAS diet quality once baseline SoFAAS



**Fig. 2.** Moderation of EDA effects on change in whole fruit diet quality by frequency of food shopping.

scores were included in the model. Gender, frequency of food shopping and frequency of fast food consumption all lost significance ( $P=0.392$ ,  $0.719$  and  $0.129$ , respectively) as moderators of the relationship between EDA and changes in total diet quality once baseline total diet quality scores were included in the model. None of the moderators tested had significant interaction effects with EDA for the HEI-2005 total fruit diet quality model. Additionally, none of the moderators tested had significant interaction effects with EXA in the strength/flexibility physical activity models.

## Discussion

The objective of this secondary analysis was to explore whether or not participant baseline

characteristics moderated intervention dose effects on diet quality and physical activity outcomes in Delta Body and Soul III. Results indicated that the intervention dose effects on diet quality, but not physical activity, were moderated by three participant baseline characteristics—employment status, individual with primary responsibility for household meal preparation and frequency of food shopping. Results reported in two previous articles indicated that not only was Delta Body and Soul III effective in improving diet quality and increasing physical activity [9], but these positive intervention effects were largely driven by level of participant engagement (or intervention dose received) [12]. The relatively few intervention dose effect moderators identified in the current Delta Body and Soul III study indicate that the positive relationships between EDA and changes in diet quality were

relatively consistent across a range of participant characteristics. Coupled with the loss of significance for some moderators (e.g. gender, individual with primary responsibility for food shopping and frequency of eating fast food) when the baseline outcome value was included in the diet quality change models suggests that the modifications for the target population were successful. That is, the fact that only three moderators significantly affected the relationships between EDA and diet quality outcomes implies that the nutrition education component of Delta Body and Soul III was effective for participants with differing sociodemographic characteristics and a range of food shopping and eating behaviors. Further, this intervention appeared to be most effective for improving diet quality in participants who most needed intervening—those with the lowest baseline diet quality. This is supported by the larger diet quality improvements apparent in participants with lower diet quality prior to intervention (i.e. at the start of the study).

Despite the relatively universal effect of EDA on diet quality changes, effect moderators identified in the current secondary analysis warrant discussion. The significant effect of EDA on whole fruit diet quality changes for monthly food shoppers as compared with the non-significant effect for weekly food shoppers is likely due to the amount of fruit purchased and spoilage issues. In a study focusing on barriers and enablers to fruit and vegetable intake among multi-ethnic adult populations, African Americans reported consuming fresh fruits and vegetables soon after purchase, but not replenishing the supply for several days due to infrequent grocery shopping [24]. Thus it is likely that monthly shoppers in this study became more aware of the many health benefits resulting from consumption of fruits, which influenced them to purchase and consume these foods more frequently. Indeed an exploration of changes in food shopping frequency revealed that significantly more intervention participants reported an increased (versus decreased) frequency in food shopping post-intervention as compared with baseline. In a previous study, African Americans reported purchasing other foods with a longer shelf

life because fruits and vegetables perish before they are consumed [24]. Understanding that frozen and canned produce can be equally nutritious and less expensive as compared with their fresh counterparts, a message delivered in the fruits and vegetables education session, likely removed the spoilage barrier that may have been present for monthly shoppers in this study.

The moderation of EDA effects on total vegetables diet quality changes by primary responsibility for meal preparation was surprising given that effects were greater for participants living in households for which others had this primary responsibility versus the participants themselves. It is possible that the education sessions influenced participants without primary responsibility to become more engaged in this chore and thereby influenced the preparation of more healthful foods, such as vegetables, in these households. However, there was no indication that participants took over primary responsibility for meal preparation post-intervention. Intervention participants who reported a change in this task post-intervention (as compared with baseline) were just as likely to report a responsibility change from other to self as they were to report a change from self to other. Hence, another possible explanation for this effect is that participants without primary responsibility for meal preparation were consuming vegetables raw (i.e. in ways that required little to no food preparation as discussed in the education sessions).

It also is feasible that the moderation of EDA effects on changes in total vegetables diet quality by both primary responsibility for meal preparation and employment was driven by baseline nutritional knowledge differences. The connection with meal preparation was likely through gender as significantly more male participants than female participants lived in households in which others had primary responsibility for meal preparation (64 versus 21%, respectively;  $P < 0.001$ ), and men tend to have less knowledge about nutrition as compared with women [25]. Likewise, higher levels of nutritional knowledge have been observed in employed individuals as compared with those who

were not employed in some capacity [25]. However, because these potential associations are speculative in nature, future studies exploring moderating effects of participant characteristics should consider accounting for nutritional knowledge at baseline.

The surprisingly weak association between strength/flexibility physical activity change and EXA largely drove the exploration of intervention effect moderators. The lack of significant moderation of this relationship by any of the sociodemographic characteristics tested lends further support for the conclusion that EXA did not appear to have significantly impacted strength/flexibility physical activity changes observed in this cohort of participants. However, the crude nature of the tool used to measure strength/flexibility physical activity likely limited precision in detecting associations. The RAPA does not allow for measures of duration and intensity, but simply presence or absence of the activity. Further, 10% of the intervention participants reported both strength/flexibility activity at baseline and thus activity increases for these participants could not be captured. No studies that either supported or refuted our findings in terms of an association between physical activity changes and participation in supervised physical activity classes or moderators of such associations could be found.

Strengths of this study include intervention in a community with elevated chronic disease prevalence, inclusion of both male and female African American adults, and exploration of intervention dose effect moderators. Additionally, nutrition education covering core facts and skills essential for selection of an appropriate diet (i.e. dietary guidelines, food group quantities needed to maintain health and reading food labels) [26] is a strength of this study. Validated measures were used for dietary and physical activity variables. However, the RAPA's ceiling effect is a limitation that should be considered when interpreting physical activity outcomes. The lack of a time frame for the food shopping and eating behavior survey items may limit their reliability. However, their inclusion as potential moderators of intervention dose effects fills a gap in the literature by moving beyond

simple descriptive use of such variables. A measure of participants' nutritional knowledge was lacking in this study and could have provided explanations for some of the moderator effects found. Additionally, this study was not specifically powered to detect moderator effects, thus additional moderators may not have been identified due to insufficient subgroup sizes. Further, our ability to detect moderator differences in the upper range of EDA was hindered by the low proportions of participants in this range. The self-report nature of these outcomes and the associated potential for recall bias and provision of socially desirable responses may be viewed as a study limitation. Further, generalizability of the results is limited because our participants were primarily African American parishioners of rural Southern churches. Finally, the temporal assignment of churches to treatment condition, which was based on practical issues (i.e. time involved for implementing the experimental condition), may have introduced bias into the study.

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## Conclusions

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Delta Body and Soul III, a culturally targeted, multi-component lifestyle intervention, did induce positive health changes in participants with a range of sociodemographic characteristics and food shopping and eating behaviors in rural Southern primarily African American adults. However, the intervention did appear less effective for individuals who were employed, lived in households in which they had primary responsibility for meal preparation, and shopped frequently for food. Although moderation results do not imply causality, we hope these exploratory findings may guide future community-based lifestyle intervention research as few theory driven or empirical accounts of such effects exist in the literature.

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## Conflict of interest statement

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None declared.

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