The No Boundaries Training Program and Its Effects on Physical Activity Levels

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Abstract

The purpose of this study is to determine if participating in a structured physical activity (PA) training program will increase total average daily step count, as well as training day and non-training day step count. Seven day step counts were collected using a New Lifestyles pedometer, NL-2000, from participants (N = 27) of a Fleet Feet No Boundaries (NoBo) training program prior to training, during week 6, and week 12 of the training program. Average daily step count increased significantly from pre-training to week 12 measures, p = .01 Non-training day step count decreased from pre-training to week 12 measures p = 001. The NoBo training program increased average daily step count/physical activity (PA) despite a decrease in step count/PA on non-training days. The NoBo program was successful in increasing overall PA levels for previously sedentary people.

Keywords: physical activity, step-counts, sedentary behavior

1. Introduction

The purposes of this study are to determine if participating in a structured physical activity (PA) program enhances PA levels on non-training days and if overall PA levels change over the course of a PA program. The Centers of Disease Control (CDC) reports that Americans perform little to no physical activity (PA) each day. In 2005, less than half of U.S. adults reported meeting the recommended PA guidelines set by the American College of Sports Medicine [ACSM] (CDC, 2005). Even fewer Americans reported participating in PA in their leisure time.

The combination of low PA levels and high fat and high calorie diets is creating a worldwide obesity pandemic (Popkin & Doak, 1998). Physical inactivity and obesity are linked to four of the top ten leading causes of death in the U.S.: heart disease, cancers, stroke, and diabetes (CDC, 2007). In the U.S., 16.6% of total deaths in 2000 were attributable to poor diet and physical inactivity (Mokdad, Marks, Stroup & Gerberding, 2004). Further, 90 billion dollars per year is spent on medical costs associated with sedentary lifestyles (Manson, Skerrett, Greenland, & VanItallie, 2004). However, vigorous forms of PA can decrease mortality risks by preventing coronary heart disease (Mason et al., 1999). The ACSM reports that with regular PA, death caused by heart disease can be reduced by 27.2%, cancer by 23.1%, and diabetes mellitus by 3.1% (ACSM, 2009).

The AHA 2007 Physical Activity Guidelines for adults ages 18 through 65 recommend that individuals should accumulate at least 30 minutes or more of moderate intensity PA such as brisk walking, lifting weights, and/or yoga (Haskell, 2007). The United States Department of Health and Human Service [USDHHS] (2008) suggests that PA should be performed in at least 10 minute bouts on five or more days per week.

Community and socially based interventions have been particularly successful in modifying PA behaviors (Estabrooks, Bradshaw, Dzewaltowski, & Smith-Ray, 2008). For example, walk/run interval style training programs tend to increase the likelihood that participants adopt physically active lifestyles (Eyler, 2009). Therefore, in this paper, I examine the extent to which a specific structured PA program (No Boundries/NoBo) will positively increase participants' PA levels on non-training days. I also compare PA levels prior to beginning the No Boundaries training program with PA levels at weeks 6 and 12 of the program.

2. Methodology

Thirty-three participants were recruited from the Southeastern Fleet Feet Shoe Store Spring No Boundaries (NoBo) training program. Of the 33 participants, 4 males and 23 females' data were used for analysis.

Fleet Feet is a national chain of specialty running stores. They are individually owned and operated, yet are linked by a network of training programs and information sharing concerning products and services. The present author's academic institutional review board approved this study and volunteers completed an informed consent form prior to participation in this study.

Step counts were used as a measure of PA.Thus, the dependent variable is step counts. Pedometers are valid and reliable measurement devices for estimating PA (Tudor-Locke, Williams, Reis, & Pluto, 2004). New Lifestyles pedometers, NL-2000 Lees, MO, were used to collect number of steps taken per day (step count) for 7 consecutive days the week prior to the beginning of the training program, during week 6, and during week 12 of the training program. The NL-2000 has been evaluated to determine its reliability in step counts. Mean step counts were within +/- 1% of actual steps taken, ICC .99 (95% CI [.98, .99]).

An activity log was issued to each participant to record when their pedometer was worn or not worn, as well as to notate whether the day was designated as a run/walk training day or a rest/cross-training day. For the rest/cross-training days, participants were also instructed to indicate if they chose to rest or cross-train. If they cross-trained, they were asked to explain the type and duration of cross-training PA. Step counts from training days and non-training days were assessed. The data collected on non-training days was compared to training days to determine if there is a difference in PA levels on non-training days. The mean of each week of data collection was compared to determine if step counts changed during the progression of the NoBo training program.

The independent variables were BMI, age and sex. The participants' sex and age were collected from the Fleet Feet participant wavier or from activity logs. Body mass index (BMI) was calculated from body mass and height measurements. Body mass, in kilogram (kg), was measured using a SECA scale Model 770 by Vogal and Halke Hamburg, Germany. Height was measured in centimeters (cm) using a SECA stadiometer and then converted to meters (m). Participants were required to remove shoes before measurements were collected. Measurements took place on a flat and even floor. The participants were asked to stand facing away from the stadiometer with feet together.

3. Data Analysis

For the NoBo study, participants had to complete at least 80% of the days of data collection for each week of data collection. Participants with missing weekend step count measurements were omitted from data analysis. Also, participants with fewer than five consecutive days of data were omitted. Participants with 4 or more missing days of data during any week of data collection were excluded from analysis. If there were days of data needed for analysis (i.e. weekday or weekend), mean step count for the remaining weekdays or remaining weekend days were used to replace the missing day's data (Kang, Zhu, Tudor-Locke, & Ainsworth, 2005; Kang, Rowe, et al., 2009). Missing data for weekdays was replaced with mean average of the remaining weekdays, and missing data for weekend measurement were also estimated by using the average weekend step count measurement. This methodological approach of individual centered missing measure estimates has been evaluated and is considered a valid and reliable way to reduce case exclusion based on missing data (Kang et al., 2005; Kang, Rowe et al.2009).

Descriptive statistics such as mean, variance, and standard deviation were calculated for the independent and dependent variables using SPSS. Repeated measures analysis of variance (ANOVA) was use to determine if changes occurred from pre-training step counts and step counts measured at week 6 and week 12. Controlling for age, sex, and BMI, the total step count for week 6 and of week 12 was compared to the total step counts measured seven days prior to beginning the NoBo training program to determine if the volume of steps changed from the beginning to the end of the program. Step counts on non-training days were compared to training days to determine if there is a difference in PA levels on non-training days at week 6 and week 12. Also, training days and non-training days step count collected from week 6 and 12 were compared each other as well as compared to preliminary step counts measured the week prior to beginning the NoBo training program. Further, non-training rest day and non-training cross-training step count were compared to training days step counts within week 6 and 12 as well as preliminary step counts. The number of days spent cross-training versus the number of days spent in rest on non-training days was evaluated through a Chi-Square comparison. Post hoc tests will be used to determine where variance occurred.

4. Results

Descriptive characteristics of the study participants who completed the NoBo training program and had sufficient step count data for all three data collection periods are presented in Table 1. Age, sex, and BMI were not found to significantly influence step counts and therefore were dropped from the analysis. The With-in Subject Effects using Greenhouse Geisser forage and sex were $F(1, 26) = .75$, $p > .05$ and BMI $F(1, 26) = .27$, $p > .05$.

For the first hypothesis, paired sample *t*-tests were used to calculate differences in mean step counts of training days verses non-training days within week 6 and within week 12. The results are reported in Table 2. Training day step counts were significantly higher than non-training day step counts within week 6 $t(26) = 7.99$, $p = .01$ and within week 12 $t(26) = 9.78$, $p = .01$.

Training day step counts from week 6 were compared to week 12 training days, as were non-training days at week 6 compared to non-training days at week 12 (see Table 2). The training daystep counts between week 6 and 12 are not significantly different $t(26) = -1.71$, $p = .10$. The results are similar for non-training daystep counts between week 6 and week 12 $t(26) = 1.94$, $p = .063$.

Table 1: Participants' Descriptive Statistics (N = 27)

Characteristics	*M*	*SD*
Age (year)	41.70	9.58
Height (cm)	166.29	7.37
Weight (kg)	90.62	21.66
BMI (kg / m^2)	32.70	7.26

Note: BMI = Body Mass Index

Table 2: Differences between Training and Non-Training Days within Training Weeks

	Mean Step Count	*SE*
Week 6		
Training	9643**	629
Non-Training	5877	530
Week 12		
Training	10679**	901
Non-Training	5003	565

Note: ** $p < .01$

The numbers of non-training days spent resting verses cross-training were examined. More non-training days were spent resting than cross-training in week 6, $\chi^2(9) = 40.89$, $p = .001$ and week 12, $\chi^2(9) = 47.64$, $p = .001$. However, between week 6 and week 12 the number of rest days $\chi^2(9) = 4.21$, $p = .90$ and cross-training days $\chi^2(9) = 3.36$, $p = .95$ were not significantly different.

Repeated measures ANOVA within subject comparison was used to determine differences among average step counts for the seven consecutive days prior to beginning the NoBo training program, seven consecutive days at week 6 and week 12 of NoBo training. The Wilk's Lambda value for the multivariate comparison was significant for mean step counts $F(2, 25) = 6.40$, $p = .006$. Mean step counts are reported in Table 3. Using the Bonferroni post hoc test, week 12 of the NoBo training program had significantly higher step counts than at 7 days prior to NoBo training program week, $p = .01$. However, pre-NoBo mean step counts and week 6 mean step counts were not significantly different, $p = .09$, nor were the step counts of week 6 and the step counts of week 12 significantly different, $p = 1.00$.

Mean daily step count measures from pre-training days (6559), week 6 non-training days (5877), and week 12 non-training days (5003) were compared to determine if non-training day step counts were influenced by participation in the NoBo training program through repeated measures ANOVA. Significant differences in the mean daily step count measures were observed, $F(2, 25) = 10.80$, $p = .001$, Wilk's Lambda = .54. Significantly more steps were observed from pre-NoBo training program days when compared to week 12 non-training days, $p = 001$. There were no significant differences found for pre-NoBo training program mean daily step count measures compared to week 6 non-training days, $p = .58$, nor for week 6 non-training mean daily step count measures to week 12 non-training mean daily step count measures, $p = .19$.

Table 3: Participants' Mean Seven Day Step Count

	M	*SD*
A: Pre-Training Step Count	6559	2753
B: Week 6 Step Count	8394	4484
C: Week 12 Step Count	7631*	3486

Note: * $p < .05$, C is significantly different from A.

5. Discussion

Training day step counts were significantly larger than non-training day step counts within week 6. Week 12 training day step counts were also significantly greater than non-training days. However, training and non-training day step counts between week 6 and week 12 were not significantly different.

5.1 Training days.

The NoBo program progressively adds more time running and decreases walk time. Further, more mileage is added with each week of the NoBo training program. Along with the increase in distance, the running interval length increases, and the time spent walking in each interval decreases. Obvious differences in step counts were between training days of week 6 to week 12 (Table 2). Bibeau et al. (2010) stated that as intensity increases and/or if rest interval decreases participants are less likely to adhere to exercise programs. However, the self-selected NoBo participants were highly motivated and the majority of the participants complied with the scheduled NoBo training days. In the sample of 33, 27 participants completed the entire 13 weeks worth of data collection which required them to participate in at least 2 of the 3 days of scheduled NoBo training days. Furthermore, the increased progression of intensity in the NoBo training program may have influenced the number of steps taken on non-training days.

5.2 Non-Training Days

Non-training mean daily step count at week 12 significantly decreased below the mean daily step count observed in the week prior to beginning the NoBo training program ($p = .001$). However, no other mean daily step count comparisons were significant (i.e. pre-NoBo to week 6, nor week 6 to week 12). Again the NoBo findings are consistent with Bibeau et al. (2010). Week12 of the NoBo training schedule contains the most miles. As the mileage increased so did the number of run/walk intervals and the time spent running. The participants compensated for the increase in intensity by participating in less PA on non-training days. To better understand this issue, non-training days were further reported as rest days and cross-training days.

5.3 Rest Versus Cross Training

More non-training days were spent resting than cross-training at week 6 ($p = .001$) and week 12 ($p = .001$). However, there was not a significant difference the number of days spent resting versus cross-training between week 6 to week 12. The larger observed number of days spent resting versus cross-training could help explain the decrease in non-training day mean daily step counts of the training week 12 to the pre-NoBo week. Further, the larger number of rest days observed in week 6could help describes the large standard deviation observed in that week of training. The participants elected to rest more often than participating in "elective" additional PA.

In a study by Dunn et al. (1999), the authors observed increases in PA in both structured exercise participants as well as non-structured "lifestyle" participants in a randomized control sample.

The participants were randomly assigned into structured exercise group (which was supervised 5 days a week for pre-planned structured exercise bouts) or a lifestyle group (that was instructed to participate in 30 minutes of moderate intensity PA on most if not all days of the week). These groups are similar to the NoBo training planned training and non-training days. Both the lifestyle as well as the structured exercise group significantly increased energy expenditure. Mean energy expenditure changes increased by .84 (kcal/kg/d) and the structured exercise group .69 (kcal/kg/d). Differences in the amount of mean energy expenditure changes were between the two groups at moderate and vigorous intensity PA. Significance was found in moderate PA for only the lifestyle group, yet vigorous PA increased for both groups. A majority of the NoBo participants performed the entire prescribed PA on training days. However, the number of days spent doing elective PA was low throughout the NoBo training program.

The participants in the Dunn et al. study (1999) who were in the structure group did not elect to participate in PA outside of the exercise program specified workload. Similar findings were observed with the NoBo participants. Since the run times increased and recovery time decreased throughout the NoBo training program participants reported few days of cross-training on their non-training days. These findings may be due to the lack of guidance. Suitable cross-training PA was not conducted regularly, and thus the participants may have only completed what was told they were required to do by the NoBo coaches. The comparisons between the Dunn et al. study and the NoBo study would have been strengthened if the measurement units were standardized, and if the days of the study had been separated into training versus non-training days.

5.4 Total Step Counts

The mean 7-day step count significantly increased from the pre-NoBo week to week 12 of the NoBo training program,$p < .05$. The week prior to NoBo training compared to week 6 of the NoBo training program was not significantly different but approached significance, $p = .09$. The standard deviation for step counts observed during week 6 likely influenced the standard error estimate, thus resulting in non-significant findings. The variation in step counts on non-training days may have influenced the total step count at week 6. Further explanation of the large variation might have been described had a comparison of mean step counts on rest day and mean step counts on cross-training days been conducted. Though the number of step counts on non-training days decreased during the NoBo training program, as a whole, the NoBo training program did positively influence PA levels from baseline to the end of the program.

Basset et al. (2010) reported Americans take an average only 5117 steps per day. Tudor-Locke et al. (2008) stated that adults who accumulate up to 5000 steps per day are sedentary while adults who accrued 5000 – 7499 steps per day are considered to have a low activity level. Further, Levine et al. (2006) reported that people who spend 2.5 or more hours per day sitting tended to be obese individuals and Thijssen et al. (2010) stated individuals who spent more time physically inactive and seated, had decreases in vascular function caused by arterial remolding. These authors have made a very clear argument for consistently accumulating PA without needing a structured, planned exercise routine. The present study sought to determine if participation in a structured run/walk exercise program resulted in changes in PA overall and on non-training days. The participants in this study increased step counts by following the NoBo Training program above baseline measurement. However, the participants were still considered to be in the low activity level group on non-training days as defined by Tudor-Locke and colleagues. The NoBo group training did increased PA levels of the previously sedentary participants. However, the increased consistency of PA performed on training days only increased from sedentary to low activity (Tudor-Locke et al., 2008). In the studies by Bassett (2010) as well as Owen et al. (2010), the authors presented that people who engage in regular PA (or regular bouts of exercise) but who are physically inactive a majority of the day, are still at risk for the negative health related issues related to physical inactivity. In the NoBo findings, a decrease in step counts observed on non-training days at week 12 may have been due to the number of rest days, a decrease in step counts on rest days, fewer step counts preformed on cross-training days, or because the pedometer was not sensitive to the PA performed on cross-training days.

5.5 Social Support

The NoBo participants were motivated individuals who performed the majority of the scheduled training day sessions. However, the participants did not participate in cross-training as often as they chose to rest on non-training days, especially during week 12 of the training program. The social support of the Fleet Feet training days for the long run as well as other elected weekly group runs reinforced the habit of increasing PA.

Unlike training days, the non-training, cross-training days were not performed as a group. Likewise, an educational seminar with peers discussing proper cross-training PA was not included in the NoBo training program. This was problematic because a majority of the NoBo participants were sedentary before starting the NoBo training program. Many participants reported not knowing what cross-training PA was or what physical activities were considered appropriate forms of cross training. Further, researchers have found social support from peer and/or family members helps previously sedentary participants successfully increase PA levels (Dunton, et al., 2009; Okun et al., 2003). However, once the person is in the habit of regularly performing PA in which case he/she would be more likely to continued increased levels of PA even without social support.

By adding an optional non-training, cross-training weekly group session to the NoBo training program, the number of cross-training days, the number of step count on cross-training days, and/or the increase of PA (not measurable by pedometers) would likely result in greater PA levels on non-training days. Further, with increased social support, the participants could adopt both training and cross-training habits that they would perform on their own. After the habit was formed, rest day step counts might also increase. Even if rest day step counts did not increase, the number of days spent resting would decrease, thus increasing the observed non-training step counts and strengthening the NoBo training program.

5. 6 Sample Characteristics

Age, sex, and BMI were not found to influence step count measurements in the NoBo sample. Similarly, neither age nor sex influenced PA levels in research conducted by Peterson et al. (2004 s). However, Peterson and colleagues found an inverse relationship between BMI and PA. By contrast, the CDC (2003, 2005, & 2008), has found statistically significant associations between PA levels and age, sex, and race/ethnicity. Possible causes of inconsistencies include the sample size, the instrumentation, the number of data collections, and the ratio of males to females. The small sample size used in the present study reduces statistical power. Further, data collection instrumentation could present discrepancies. Leisure time PA survey instruments used in these studies do not measure PA in the same manner as pedometers. Surveys measure a participant's perception of PA performed in a subjective fashion, while pedometers objectively measure the number of steps taken by a participant. In a meta-analysis conducted by Kim, Kang, Lee, and Park (2011), International Physical Activity Questionnaire (IPAQ) values for PA have a low correlation (r =.20) with pedometers. Data gleaned from these tools are not identical; therefore, comparing studies with these different measurement tools should be done carefully.

A third reason for the mixed findings concerning step count and demographics is duration of the study, including the number of data collections. The CDC used a single sample population and collected data once, the Peterson et al. study used a single sample and collected data multiple times over 15 years, and the NoBo data were collected from three different sampling times over a total of 13 weeks in a single population. The NoBo sample had a much smaller amount of data than the other studies. The longer studies have more robust data resulting in more statistical power. Finally, the ratio of males to females may have influenced the results in the present study.

5. 7 Limitations and Recommendations for Future Research

This study recorded step counts to estimate total PA. Pedometers cannot measure all PA. The variation of step counts observed on non-training cross-training days that largely influenced the step count variation in week 6 may have resulted due to use of pedometers. Many forms of PA are not locomotive in the plane that pedometers recognize or the PA is of a greater intensity, which is also not measureable with the use of a pedometer. Examples of PA that are not measured by pedometers include but are not limited to the following, swimming, bicycling, rowing, weight lifting, and yoga. The cross-training activities were reported by the participants in their survey. Future researchers should consider using a tri-axial pedometer and a validated PA survey in data collection to explain more variation in observed step counts.

Further, there was a wide variety between and within subject consistency in participation in elective cross-training over the entire NoBo training program. Some participants did not participate in any cross training. When asked, many participants were unsure what activities were considered cross training. A majority of the NoBo participants consistently completed the scheduled training days and were not consistent with cross training. In the future, the NoBo training program could further increase consistent PA by holding a additional cross-training educational session or by adding an optional cross-training group meeting day to promote PA on non-training days. Future research should include analyses comparing the mean daily step count of rest days to cross-training days.

The sample was a convenience sample recruited from participants that were already enrolled in the NoBo training program. These participants were motivated to increase their PA levels. Likewise, there was a great group adherence to the scheduled training days. The social group setting also supported the motivated individuals. In previous studies, social support reinforced the increases in PA levels (Estabrooks et al., 2008; Okun et al., 2003). Future research should include a control group, a larger sample size that including more male participants, as well as other PA measurement tools to determine to what extent the NoBo training program was successful in increasing PA on non-training days.

6. Conclusions

The NoBo training program increased PA levels for participants from baseline measures to the end of the training program. Therefore, the program was successful in increasing PA levels. However, the mean daily step count from pre-NoBo to week 12 of the training program significantly decreased. To increase PA on non-training days, future NoBo program cycles should consider including educational classes or optional group weekly cross-training meeting days.

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