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Effectiveness of a 12-month randomized clinical trial to increase physical activity in multiethnic postpartum women: Results from Hawaii's N Mikimiki Project

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Abstract

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Objective—Few postpartum ethnic minority women perform leisure-time moderate-to-vigorous physical activity (MVPA). The study tested the effectiveness of a 12-month tailored intervention to increase MVPA in women with infants 2–12 months old.

Methods—From 2008–2011, women (n=311) with infants (average age = 5.7 months) from Honolulu, Hawaii were randomly assigned to receive tailored telephone calls and access to a mom-centric website (n=154) or access to a standard PA website (n=157). MVPA was measured at baseline, 6, and 12 months using self-report and accelerometers.

Results—Controlling for covariates, the tailored condition significantly increased self-reported MVPA from an average of 44 to 246 minutes/week compared with 46 to 156 minutes/week for the standard condition ($p=0.027$). Mothers with 2 children had significantly greater increases in MVPA in response to the tailored intervention than those with one child ($p=0.016$). Accelerometer-measured MVPA significantly increased over time ($p=0.0001$), with no condition differences. There was evidence of reactivity to initially wearing accelerometers; the tailored intervention significantly increased MVPA among women with low baseline accelerometer MVPA minutes, but not among those with high minutes ($p_{\text{interaction}}=0.053$).

Conclusion—A tailored intervention effectively increased MVPA over 12 months in multiethnic women with infants, particularly those with more than one child.

Keywords

exercise; postnatal; randomized controlled trial; technology

1. Introduction

Previous studies have shown that women with children are less active than their same aged female peers without children (Albright, Maddock, & Nigg, 2005; Allender, Hutchinson, & Foster, 2008; Bellows-Riecken & Rhodes, 2008; W. J. Brown, Heesch, & Miller, 2009; W. J. Brown & Trost, 2003; Engberg et al., 2012), and that there are significant changes in health behaviors, including reductions in moderate-to-vigorous physical activity (MVPA), during the postpartum period (Borodulin, Evenson, & Herring, 2009; Durham et al., 2011; Evenson, Herring, & Wen, 2012; Haas et al., 2005; Olson, Strawderman, Hinton, & Pearson, 2003). These changes place this vulnerable population at risk for weight gain and development of chronic health conditions such as hypertension, obesity, and diabetes (W. J. Brown & Trost, 2003; Gould Rothberg, Magriples, Kershaw, Rising, & Ickovics, 2011; Metzger, 2007; Olson et al., 2003; Retnakaran et al., 2010; Walker, Fowles, & Sterling, 2011).

Recent studies have tested the effectiveness of leisure-time physical activity (PA) interventions, alone or in combination with dietary change/weight loss in postpartum women (Chang, Nitzke, & Brown, 2010; Cramp & Brawley, 2006; Da Costa et al., 2009; Davenport, Giroux, Sopper, & Mottola, 2011; Fahrenwald, Atwood, Walker, Johnson, & Berg, 2004; Fjeldsoe, Miller, & Marshall, 2010; H. D. McIntyre, Peacock, Miller, Koh, & Marshall, 2012; Taveras et al., 2011). However, few PA interventions have intervened only on PA (Fahrenwald et al., 2004; Fjeldsoe et al., 2010; Miller, Trost, & Brown, 2002) with just three studies focusing primarily on ethnic minority postpartum women, most of whom

were African-Americans or Hispanics.(Chang et al., 2010; Clarke et al., 2007; Ostbye et al., 2009) Several studies were short-term (< 6 months) leaving longer term (12-month) interventions untested. (Fahrenwald et al., 2004; Fjeldsoe et al., 2010; Miller et al., 2002; J. F. Norman, Pozehl, Duncan, Hertzog, & Krueger, 2012) Therefore, little is known about the effectiveness of PA interventions with ethnic minorities including Asian-Americans, Native Hawaiians, and other Pacific Islanders (AA and NHOPI). This is important because the number of AA and N HOPI living in Hawaii is 981,129 (72.1% of the population) and, across the U.S., is over 16 million.(United States Census Bureau, 2010, 2011) This is estimated to increase to 47 million by 2060.(United States Census Bureau, 2012a, 2012b)

Since new mothers are high-end users of technology(Hogue & Benezra, 2009), PA interventions are needed that can effectively combine technology and tailored counseling to promote the initiation of MVPA during a time when substantial developmental changes occur in an infant. Telephone and internet interventions have effectively increased PA in a range of populations.(Cavallo et al., 2012; Eakin, Lawler, Vandelanotte, & Owen, 2007; Fanning, Mullen, & McAuley, 2012; Fjeldsoe et al., 2010; Fjeldsoe, Miller, O'Brien, & Marshall, 2012; Marshall, Miller, Graves, Barnett, & Fjeldsoe, 2013) Building on previous research, a PA intervention tailored to meet the needs of multiethnic mothers of infants less than 12 months of age was designed.(Albright, Maddock, et al., 2005; Albright, Maddock, & Nigg, 2009; Chang et al., 2010; Fahrenwald et al., 2004; Fjeldsoe et al., 2010; Miller et al., 2002; Ostbye et al., 2009)

This study compared the effectiveness of two, 12-month technology-based PA interventions designed to increase MVPA in postpartum women. One was a theoretically-derived multi-component PA intervention using constructs previously proven to be effective in PA interventions.(Albright, Pruitt, et al., 2005; Chen, Sallis, Castro, Hickman, & Lee, 1998; Collins, Lee, Albright, & King, 2004; Marcus, Ciccolo, & Sciamanna, 2009; Marcus et al., 2000; Marshall et al., 2003; Miller et al., 2002) The other intervention used a 'standard' PA website as a comparison. We hypothesized that the tailored intervention would significantly increase MVPA more than the standard intervention, as measured by surveys and accelerometers.

2. Methods

Study Design

The N Mikimiki (Hawaiian for “the active ones”) Project was a 12-month parallel randomized controlled trial comparing the effectiveness of a tailored telephone counseling plus website (TTCW) PA intervention to a standard website-only (SWO) PA intervention. (Albright et al., 2012) Using pilot data,(Albright et al., 2009) a sample size of 100 per condition by study end was needed to detect a medium effect size of Cohen's $d=0.4$ (reflecting a difference of 30 minutes/week), with $\alpha=0.05$ and 80% power. More details on the study are reported elsewhere; briefly, the study recruited healthy women who were not regularly active (i.e., < 30 minutes MVPA/wk), were 18–45 years of age, had BMIs from 18.5 to 40 kg/m² and had an infant between 2–12 months of age.(Albright et al., 2012)

Recruitment

From 2008 through 2010, 311 postpartum women were recruited using: (1) community-wide promotions and (2) a health care organization (Kaiser Permanente, KP). Recruitment strategies are summarized in a CONSORT flow diagram (Figure 1). All study protocols and assessments were approved by the University of Hawaii's Human Studies Program and the KP Institutional Review Board. Participants signed an informed consent prior to enrollment. A Data Safety Monitoring Board (DSMB) monitored severe adverse events and other study outcomes over the course of the study.

Randomization

Randomization was implemented within four strata defined by recruitment source and parity, and within blocks of size 4, 6, or 8, which were used to ensure balance in assignment over the course of the study. (Friedman, Furberg, & Demets, 1998) Assessment staff were blinded to the participant's assigned condition and intervention staff were blinded to primary outcomes.

Study Conditions

Participants in the SWO condition were referred to a condition-specific website that included links to "standard" (i.e., for males/females of any age) PA credible websites and resources on how to increase PA. (Albright et al., 2012) Of the 157 women in this condition, 20% did not visit the website, 17% visited once, 55% visited 2–10 times, and 8% visited 11 times, for a total of 533 page views over the 12 months.

The TTCW condition addressed key psychosocial factors including: self-efficacy to overcome barriers to leisure-time MVPA (Fahrenwald & Walker, 2003; Hinton & Olson, 2001a, 2001b; Lombard, Deeks, Ball, Jolley, & Teede, 2009), enlisting support for PA (C. A. McIntyre & Rhodes, 2009; Miller et al., 2002), and navigating environmental factors (e.g., finding "stroller friendly" parks). Participants in this condition were referred to a condition-specific tailored website, and received 17 telephone calls with a counselor who used motivational interviewing techniques to problem-solve barriers and set future PA goals (incrementally building up to 150 minutes/week of MVPA). They were issued a pedometer (New Lifestyles NL-1000) (Gilson et al., 2013; Samuels, Raedeke, Mahar, Karvinen, & DuBose, 2011) to track and set goals using steps (with goal of 10,000 steps a day). Tailored mom-centric PA "resource directories" and newsletters were key components of the website. Both the written information (website/newsletters) and the telephone counseling calls were developed/delivered using Resnicow's framework for creating culturally sensitive interventions which revolves around two dimensions: surface structure and deep structure. (Resnicow, Baranowski, Ahluwalia, & Braithwaite, 1999) The intervention's use of surface structure included external representations of AA and NHOPI in Hawaii (e.g., artwork/photos depicting Asian/NHOPI women and infants), and for deep structure the ethnically matched counselors were knowledgeable and respectful of the Native Hawaiian's cultural values of family (or 'ohana) and Japanese cultural values of social harmony and interdependence within the family. (Ka'opua, Park, Ward, & Braun, 2011; Mau et al., 2001; Maxwell et al., 2014; McLaughlin & Braun, 1998)

A majority (70%) of TTCW women received 13 or more calls, and the average duration of the calls was 12.7 (SD= 6.4) minutes. Of the 154 women in the TTCW condition, 23% did not visit its website, 6% visited once, 31% visited 2–10 times, 18% visited 11–20 times, and 22% visited 21 times, for a total of 2,092 page views over the 12 months.

Fidelity to the Intervention Protocol

Five percent of the 1,586 recorded telephone counseling calls were randomly selected for assessment of fidelity. Fidelity to the key intervention components (e.g., goal setting, barrier resolution, resources) was 88%. (Albright et al., 2012) Setting the woman's next MVPA goal was discussed in 100% of the evaluated calls.

Study Measurement Procedures

A detailed description of the study measures is available elsewhere (Albright et al., 2012); briefly, self-administered surveys were completed at baseline, and 1, 6, and 12 months post-baseline, with accelerometer data collected at baseline 3, 6, and 12 months. Participants in both conditions were given a total of \$60 in gift cards for participation.

Physical Activity Survey—The Active Australia Survey instrument (AAS (W. J. Brown, Burton, Marshall, & Miller, 2008)) assessed frequency and duration of the following activities performed for at least 10 minutes in the last week: walking (“for recreation, exercise, or to get from place to place”), moderate intensity PA (e.g., leisure swimming) and vigorous PA (e.g., jogging). The AAS has been shown to have good test-retest reliability, (W. J. Brown, Trost, Bauman, Mummery, & Owen, 2004) validity via objective accelerometer-measured PA, (W. J. Brown et al., 2008; Fjeldsoe, Winkler, Marshall, Eakin, & Reeves, 2013) and to be sensitive to change. (Reeves, Marshall, Owen, Winkler, & Eakin, 2010) A MVPA summary score was created as the sum of minutes of walking and moderate-to-vigorous PA, with vigorous activity time weighted by two. (Albright et al., 2012; W. J. Brown & Bauman, 2000)

Psychosocial Measures—Detailed descriptions, including psychometric properties, of all the psychosocial measures are available elsewhere. (Albright et al., 2012) Validated instruments included self-efficacy to overcome barriers to PA (e.g., sick infant) (Albright, Maddock, et al., 2005; Albright et al., 2009; Albright et al., 2012; Garcia & King, 1991; Miller et al., 2002), perceived barriers and benefits of regular PA (Albright et al., 2012; Heesch, Masse, & Dunn, 2006; J. F. Sallis, Calfas, Alcaraz, Gehrman, & Johnson, 1999), and social support for exercise. (J.F. Sallis, Grossman, Pinski, Patterson, & Nader, 1987) Finally, the Edinburgh Postnatal Depression Scale assessed depressive symptoms. (Cox, Holden, & Sagovsky, 1987) After the 12-month active intervention period participants in both conditions completed anonymous evaluations of how satisfied they were with their intervention and how helpful specific intervention components were to their efforts to increase MVPA.

Accelerometer Data for MVPA—A sealed Lifecorder EX downloadable accelerometer (New Lifestyles NL-2200, Inc, MO) was used to collect objective MVPA minutes at baseline, 3, 6, and 12 months. Participants wore the device for 7 days (during waking hours)

at each time point. The Lifecorder EX device recorded time spent at proprietary intensity levels (microactivity and levels 1–9) in 4 second and 2 minute epochs. Lifecorder's level 4 was previously estimated to have a MET equivalence of 2.9(Kumahara et al., 2004), and was selected as our cutoff for MVPA that is generally defined as MET 3.0.(Ainsworth et al., 2000) Thus, MVPA was computed as time spent at Lifecorder levels 4–9, averaged across valid days. Valid days were defined as 10 hours per day of wear, excluding bouts of zero activity that were 20 minutes or longer, which were considered periods when the device was not worn. The minimum number of valid days for inclusion in the analysis was three or more, where at least one was a weekend day.

Statistical Analysis

The primary analyses (conducted 2011- 2013) compared change in minutes of MVPA from baseline to 12 months in the two conditions using an intention to treat strategy. Outcome measures were transformed based on the Box-Cox method to better meet model assumptions.(Snedecor & Cochran, 1989) Self-reported MVPA weighted for intensity was transformed as $(y+1)$ to the 0.25 power. The accelerometer MVPA data were not transformed. Mixed linear growth models,(Singer & Willett, 2003) were used to estimate and compare differences in MVPA over time between conditions. These models, also called random coefficient models, include random linear trends (intercept and slope terms) for each individual and fixed terms for intercept and slope for each condition (via main effect and interaction terms) estimating the overall expected value, as well as fixed effects for covariates. The treatment effect was assessed by the F test of the fixed interaction parameter for time and intervention group. Models were run with and without adjustment for covariates selected a priori. Adjustment variables included: age, race, BMI, number of children, education level, full-time employment, Edinburgh postnatal depression scale, baby's age, history of gestational diabetes mellitus (GDM), source of recruitment, and number of years lived in Hawaii. The effect size was calculated by taking the differences between the means at month 12 predicted from the adjusted model, divided by the standard deviation for the difference computed from the within and between subject variance components. Additionally, moderation was tested in the mixed growth model by the F-test for three-way interaction terms between time, study condition, and potential moderators (including the adjustment variables and baseline PA level); the model included all two-way interaction terms.

About one-quarter of women who were randomized did not provide information by survey on MVPA at 12 months, and this differed by condition (18% for SWO and 32% for TTCW). Thirty-seven percent of women did not provide accelerometer data at 12 months, which was not different by condition. Model results are presented using all available data (includes women with at least one MVPA measurement and all covariates at baseline) However, analyses were conducted to address attrition and missing outcome data. Correlates of attrition, identified using a stepwise logistic model, were the TTCW treatment condition, younger age and higher BMI for the survey data, and younger age, higher BMI, Hawaiian race and lower education for the accelerometry data. The impact of missing MVPA data on the validity of study results was assessed for the survey data, but not for the accelerometer data due to the greater extent and non-differential nature of the missing data. First, a pattern

mixture model (Hedeker & Gibbons, 1997) was used to compare the treatment effect between those who completed assessments and those who did not. Multiple imputation (MI) (Little & Rubin, 2002; Muthén & Muthén, 1998–2010) was then performed separately by experimental condition, accounting for all adjustment variables and variables related to attrition. Results were aggregated using standard MI techniques across 10 data sets.

Analyses were primarily conducted using SAS, version 9.2 (SAS Institute, Inc., Cary NC), and Mplus, version 6. (Muthén & Muthén, 1998–2010) P-values were two-sided, with $p < 0.05$ considered statistically significant and $0.05 > p > 0.10$ suggestive for interaction effects.

3. Results

Of the 311 participants randomized into the study, 154 were randomized to TTCW and 157 to SWO (see Figure 1 for recruitment sources). Table 1 lists the number of women who provided surveys or accelerometer data at baseline and at 1, 3, 6 and 12 months post-baseline. Approximately 75% (233) of the 311 participants completed the 12 month intervention and survey. This differed by treatment group (TTCW: 68%; SWO: 82%, $p < 0.05$ by chi-square test). Twelve month accelerometer data were available for 63% of women, with no condition differences (60% for TTCW and 66% for SWO, $p = 0.28$). The number of valid days an accelerometer was worn at each timepoint (Table 1) was also not significantly different by condition ($p = 0.53$).

Baseline socio-demographic characteristics of women in both conditions are shown in Table 2; there were no significant differences between conditions. In addition, there were no significant baseline differences between TTCW and SWO in: self-reported MVPA (median 40 min/wk for both, $p = 0.95$); accelerometer MVPA minutes (median: 132 and 151 min/wk, respectively, $p = 0.15$), or in the psychosocial variables. A majority of the sample (85%) were ethnic minorities, most of whom were AA or NHOPI.

Over the 12 month period, 31 women (10%) ended their participation in the trial prior to completion because they were “too busy”, the intervention was “too much”, etc. (Figure 1). (Albright et al., 2012) Twenty –eight women’s participation was ended due to a pregnancy, and three women were removed due to medical problems, judged by the DSMB and the IRB, to be unrelated to PA or the interventions.

Moderate-to-Vigorous Physical Activity Results

For the change in self-reported minutes of MVPA/wk, there was a significant interaction between time and condition ($p = 0.027$), with the TTCW condition showing greater improvement from baseline to 12 months (202 min/week) than in the SWO condition (110 min/week) (see Table 3 and Figure 2). The effect size for the difference at 12 months was 0.36. The findings were not markedly biased by differential attrition. The pattern mixture model found that the treatment effect did not differ among those who completed assessments compared to those who did not ($p = 0.75$). Models using multiple imputation ($n = 311$) and complete cases ($n = 231$, with baseline and 12 month MVPA data and all covariates) yielded similar results. (Table S5).

The analysis of possible moderators of the change in self-reported MVPA found that number of children was significant ($p=0.016$, Table 3). Among women with 2 or more children, MVPA increased by 261 min/week in the TTCW condition, and by 89 min/week in the SWO condition. Conversely, among women with only one child, the SWO condition had a similar increase (158 min/wk) to the TTCW condition (125 min/wk). No other moderator was found for self-reported MVPA.

For physical activity measured via accelerometry, the sample size was 259 which includes women with valid accelerometry data at any time point. MVPA increased over time in both TTCW and SWO conditions ($p's < 0.0001$ for the trends). However, there was no significant interaction between condition and time (Table 4). The effect size at 12 months was 0.10. To understand the difference between accelerometer and self-report for change in MVPA by condition, we conducted moderator analyses and found a significant effect of baseline accelerometer PA level. Women in the TTCW condition exhibited a greater increase in MVPA than the SWO condition, among women whose baseline levels were below the median, but not among those above the median ($p_{interaction}=0.053$). It is also possible that the intervention effect was influenced by baseline BMI ($p=0.09$, Table 4). Women with a baseline BMI $< 25 \text{ kg/m}^2$ in TTCW had a greater increase in MVPA than overweight or obese women in this condition, while this pattern was not found for the SWO condition. No other moderator was found for accelerometer-based MVPA.

4. Discussion

The N Mikimiki Project compared the effectiveness of two 12-month PA interventions, both of which had online components. The tailored intervention included 17 telephone counseling calls when MVPA goals were set and barriers were resolved. As hypothesized, the 12-month increase in self-reported MVPA was significantly greater in the tailored telephone counseling intervention (202 min/week) over the 12 month intervention, than in the website only condition (110 min/wk). Conversely, the accelerometry MVPA showed increases over the 12 month period (from 163 to 215 min/wk for TTCW and 162 to 203 min/wk for SWO), but condition differences were not statistically significant.

Due to differences in study samples (e.g., race/ethnicity, BMI, and age of infant), length of the PA intervention, intervention methods (e.g., group-based versus home-based PA), study outcomes (weight loss versus PA alone) and methods for assessing MPVA, it is difficult to directly compare this study's findings with those of previous studies with postpartum women. However, two previous PA interventions with postpartum ethnic minority women, over a comparable time period, reported non-significant increases in PA. (Ostbye et al., 2009; Taveras et al., 2011) Thus, this study's significant differential increase in self-reported MVPA for a 12-month tailored MVPA telephone plus website intervention represents a unique finding for postpartum women with infants. Several other studies with postpartum women have reported similar between-group differences in minutes/week of MVPA following a PA intervention, but their interventions were shorter (i.e., 8–12 weeks) or used supervised PA classes. (Clarke et al., 2007; Cramp & Brawley, 2006; Fahrenwald et al., 2004; Fjeldsoe et al., 2010; Maturi, Afshary, & Abedi, 2011; H. D. McIntyre et al., 2012; Monteiro et al., 2014)

This study successfully recruited 311 postpartum women but had difficulty with retention and completion of study assessments, largely due to participants becoming pregnant. Seventy percent of women in the TTCW condition received most (76%) of the planned telephone contacts over 12 months. Although most participants in both conditions visited their condition-specific website at least once and anonymous 12-month evaluations of TTCW's helpfulness and satisfaction with its components were very high (see Appendix), the number of repeat visits to the website were suboptimal, particularly among the TTCW participants after the first 2–3 months of the intervention. The TTCW website was updated regularly with a list of local events appropriate for new mothers with infants or other children, so new information was available over time. However, the two condition-specific websites were not formatted for a Smartphone, so participants may have found accessing them via a desktop/laptop inconvenient as their infants became mobile. Future online interventions' text/photos/videos should be formatted so they are easily viewed on a Smartphone.

Although the Na Mikimiki Project's sample was similar to postpartum samples reported in previous PA intervention studies with respect to age of mother, marital status, percent primiparous, and average number of children (Albright et al., 2012; Chang et al., 2010; Fjeldsoe et al., 2010; E. Norman, Sherburn, Osborne, & Galea, 2010; Ostbye et al., 2009), the proportion of ethnic minority women (85%) was higher than in two studies that included African American postpartum women (Mothers in Motion (MIM=52%) and Active Mothers Postpartum (AMP=45%)). (Chang et al., 2010; Ostbye et al., 2009) Other socio-demographic factors that differed across these studies were lactation rates, women's employment status, BMI and infant's age. (Albright et al., 2012) Some of these socio-demographic characteristics were controlled for in these studies' analyses; however, the adjustment was not consistent across studies and moderator analyses were not consistently reported. Although our sample consisted of several culturally distinct races in sufficient numbers (white, Japanese, Filipino, Asian mixed, Native Hawaiian and other Pacific Islanders, and more than one ethnicity/race), race was not a significant moderator of the increase in MVPA. None of the three previous PA intervention studies with postpartum women that included African-American or Hispanic women reported differences by race/ethnicity in their PA outcomes. (Chang et al., 2010; Clarke et al., 2007; Ostbye et al., 2009) Therefore, it appears that when a MVPA intervention is culturally sensitive and carefully tailored to meet the needs of its population, participants respond equally well across race/ethnic groups.

In any long-term study, retention is a key component in the interpretation of a study's results. The proportion of the Na Mikimiki sample that completed multiple follow-up surveys over 12 months was comparable to the rates reported by Ostbye and colleagues (Ostbye et al., 2009), with pregnancy being a primary reason for loss-to-follow up in both studies.

An interesting finding was that women with 2 or more children responded better to the TTCW intervention than those with one child; however, there were no differences between these two groups in the time spent on the telephone with the counselor ($p=0.83$). The ability of women with two or more children to increase their MVPA, more than those with one

child, could reflect better time management skills, or being more secure in their role as a mother and not “feeling guilty” if they spent time on themselves for PA.

The results from the self-reported data and accelerometer data differed for MVPA; the subjective measure confirmed the hypothesis, while the objective measure did not. The difference could be due to several factors, including recall bias for the surveys and reactivity caused by the accelerometer.(Clemes & Deans, 2012; Motl, McAuley, & Dlugonski, 2012) The latter is more likely as the women in this study reported performing little MVPA on the survey. Yet, the levels registered by the accelerometer at baseline suggested that they were physically active. Also, the mean MVPA min/week was very similar for the two methodologies at 12 months when the novelty of the accelerometer would have subsided. This was confirmed by the fact that among women below the median for PA accelerometer level at baseline, the TTCW condition exhibited a greater change in PA than the SWO condition, while this was not true for the women above the median ($p=0.053$). Comparing results that used different types of evidence calls to attention the important differences between measurement methods. For example, women would likely perceive walking while pushing a stroller or walking with the baby in a shoulder-strap carrier as moderate-vigorous activity. Objective measures of energy expenditure confirm the accuracy of this perception. (W.J. Brown, Ringuet, Trost, & Jenkins, 2001) However, the accelerometer would count this activity as ‘light’ because of the lower velocity/acceleration, without accounting for added effort when the user is pushing or carrying a heavy object. This illustrates the importance of multiple indicators of PA when assessing intervention effectiveness to capture the complexity of PA. Conclusions on the effectiveness of an intervention using a single methodology may miss important related outcomes.(Nigg, Jordon, & Atkins, 2012)

Limitations

Since the N Mikimiki sample included a high proportion of married women with relatively high educational achievement (78% college educated), the results may not be generalizable to women from socio-economically disadvantaged backgrounds. Also, given that the sample consisted of women who were interested in becoming more active, they may have been more receptive to the intervention than other postpartum women. Another limitation was that, by 12 months, loss-to follow-up was 25% for the surveys and 37% for the accelerometers. Also, attrition tended to be differential; perhaps because of the commitment involved; this could have led to biased results. However, results from several types of sensitivity analyses verified that patterns of missing data did not bias the results. Also the correlates of attrition in our study are similar to those found in other exercise interventions and weight loss interventions involving physical activity, which include age, education, and a higher BMI.(Linke, Gallo, & Norman, 2011; Moroshko, Brennan, & O'Brien, 2011; Neve, Collins, & Morgan, 2010; Peels et al., 2012) Nonetheless, future physical activity interventions should make every effort to retain participants with, for example, a higher BMI at baseline, by including strategies/messages that directly address issues important to this subgroup (i.e., being physically active is important regardless of how much you weigh or whether you are trying to lose weight or not). Also, lower retention rates for ethnic minorities in randomized clinical trials are a concern;(Arikawa, O'Dougherty, Kaufman, Schmitz, & Kurzer, 2012; Moroshko et al., 2011; Murphy & Williams, 2013; Osann et al.,

2011) however, we used several strategies that have been shown to maximize retention in clinical trials (i.e., establishing rapport, participants' perception of the study as informative, etc.) (Barnett, Aquilar, Brittner, & Bonuck, 2012; D. R. Brown, Fouad, Basen-Engquist, & Tortolero-Luna, 2000; Butler et al., 2013) Further studies are needed on the sustainability of the behavior changes achieved. A further limitation is that the separate treatment effects attributable to the mom-tailored website and the attention due to the tailored telephone counseling calls cannot be distinguished because the TTCW intervention was designed to include both the online and telephone elements.

5. Conclusion

This was the first study to compare the effectiveness of two online PA interventions using a sample composed largely of postpartum women with Asian American and Native Hawaiian or Pacific Islander heritage. Over 12 months both interventions effectively increased MVPA as measured via self report and accelerometer. However, the tailored intervention yielded significantly greater improvements in self-reported MVPA than the standard condition. The positive results over a time period that was demonstrably longer than most previous studies (12 months versus 2–6 months) and the finding that the tailored intervention was more effective in women with two or more children, than in women with one child, represent unique and noteworthy contributions to the literature. These results are also in contrast to other weight loss or PA interventions that failed to show any significant change in MVPA in postpartum women.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Highlights

- Compared effectiveness of 2 moderate-to-vigorous physical activity (MVPA) conditions
- Randomized controlled trial recruited 311 postnatal women, followed for 12-months
- Telephone/website intervention was tailored to ethnic minority women with infants
- Tailored condition increased MVPA minutes/week more than standard ($p = 0.027$)
- Mothers with 2 children increased MVPA more than those with one child ($p=0.016$).

Figure 1. Accrual and Retention of Participants – CONSORT* Flow Diagram: Honolulu, Hi: 2008–2011

*Consolidated Standards of Reporting Trials; see: <http://www.consort-statement.org/home/>

^aParenting magazines (readership): Island Family/Island Baby (45,000), Hawaii Parent (45,000), Hawaii Baby & Toddler (20,000).

^bNewspapers (readership): The University of Hawaii student newspaper (10,000), Honolulu Weekly (38,000), Star Bulletin (63,000), Star Bulletin: Progress (177,000), Midweek (268,000), Hawaii People (189,000), and Honolulu Advertiser (158,155).

^cKaiser Permanente staff sent a maximum of 3 postcards to mothers who met the basic eligibility criteria as determined by electronic medical records. For each recruitment attempt, eligible mothers were mailed a returnable postcard, followed by a phone call to non-responders.

^dDid not meet inclusion criteria because they were already exercising ($n = 66$), pregnant/ planning to become pregnant ($n = 13$), using insulin ($n = 1$), planning to leave Oahu ($n = 7$), unwilling to complete assessments or office visits ($n = 4$), or BMI < 18.5 ($n = 8$) or BMI > 40 ($n = 9$), no health insurance ($n = 8$), cancer ($n = 5$), heart disease/attack ($n = 1$), stroke ($n = 1$), infant < 2 mo ($n = 1$), infant > 12 mo ($n = 7$), twins ($n = 2$), did not have GDM in last pregnancy ($n = 3$).

^eActive Decline = Declined to be scheduled for a baseline visit; Passive Decline = Failed to attend scheduled baseline visit or failed to attend baseline visit after being rescheduled 3 times

^fReceived at least 1 telephone call

^gDiscontinued participation – reason unknown.

Figure 2.
Self-reported Minutes of MVPA/week by study condition over time. Honolulu, Hawaii:
2008–2011

Table 1
Completion of Surveys and Accelerometers over time by study condition. Honolulu, Hawaii: 2008–2011

	Tailored Telephone Counseling plus Website (n=154)				Standard Website Only (n=157)			
	Retained	Survey Completed	Accelerometer Returned	Valid ^a	Retained	Survey Completed	Accelerometer Returned	Valid
Baseline	N 154	154	142	120	157	157	152	122
% of Retained		100	92.2	77.9		100	96.8	77.7
% of Randomized		100	92.2	77.9		100	96.8	77.7
Month 1 ^b	N 149	132	-	-	155	139	-	-
% of Retained		88.6				89.7		
% of Randomized		85.7				88.5		
Month 3 ^c	N 147	-	126	70	155	-	139	81
% of Retained			85.7	47.6			89.7	52.3
% of Randomized			81.8	45.5			88.5	51.6
Month 6	N 125	110	101	52	147	133	127	70
% of Retained		88.0	80.8	41.6		90.5	86.4	47.6
% of Randomized		71.4	65.6	33.8		84.7	80.9	44.6
Month 12	N 113	104	93	50	136	129	104	66
% of Retained		92.0	82.3	44.2		94.9	76.5	48.5
% of Randomized		67.5	60.4	32.5		82.2	66.2	42.0

^a Defined as having three or more days with at least 10 hours per day of wear, excluding bouts of zero activity that were 20 minutes or longer, which were considered periods when the device was not worn, with at least one weekend day.

^b Accelerometer not distributed to participants

^c Survey not distributed to participants

Table 2

Baseline socio-demographic characteristics by study condition (N =311) Honolulu, Hawaii: 2008–2011

Characteristic, % (n)	Tailored Telephone Counseling plus Website (N = 154)	Standard Website Only (N = 157)	p ^a
Woman's M _{age} (SD)	31.6 (5.5)	32.1 (5.9)	0.46
Baby's M _{age} in months (SD)	5.3 (2.8)	5.8 (2.9)	0.14
Mean number of children (SD)	2.0 (1.0)	1.9 (0.9)	0.66
Mean BMI, kg/m ² (SD)	28.4 (5.5)	27.4 (5.0)	0.25
BMI categories			0.64
< 18.5	0.6 (1)	0	
18.5–24.9	30.5 (47)	35.7 (56)	
25–29.9	33.1 (51)	32.5 (51)	
30–34.9	22.7 (35)	22.9 (36)	
35	13.0 (20)	8.9 (14)	
Race ^b			0.39
Asian	34.6 (53)	33.3 (52)	
Japanese	5.9 (9)	10.9 (17)	
Filipino	15.7 (24)	9.0 (14)	
Mixed/Other Asian	13.1 (20)	13.5 (21)	
Native Hawaiian / other Pacific Islander	32 (49)	31.4 (49)	
White	13.1 (20)	17.3 (27)	
Other Mixed Race	17.6 (27)	15.4 (24)	
Other (Black, Native American)	2.6 (4)	2.6 (4)	
Ethnicity			
Hispanic ^c	15.8 (24)	19.5 (30)	0.45
Number of Children			0.33
Primiparous	37.7 (58)	35.7 (56)	
Two children	35.1 (54)	42.7 (67)	
Three or more children	27.3 (42)	21.7 (34)	
Employment			0.49
No paid employment/family leave	39.0 (60)	33.1 (52)	
Paid part-time	18.2 (28)	22.3 (35)	
Paid full-time	42.9 (66)	44.6 (70)	
Born in U.S.	85.1 (131)	84.7 (133)	1.00
History of Gestational Diabetes ^d	16.9 (26)	15.3 (24)	0.70

	Tailored Telephone Counseling plus Website (N = 154)	Standard Website Only (N = 157)	
Education Level			0.55
Less than High School	3.9 (6)	3.2 (5)	
High School graduate	19.0 (29)	17.8 (28)	
Some College	24.8 (38)	17.8 (28)	
Bachelor's degree	20.9 (32)	23.6 (37)	
Post graduate	31.4 (48)	37.6 (59)	
Marital Status			0.31
Never Married	18.8 (29)	15.9 (25)	
Married/ Living as married	76.6 (118)	82.2 (129)	
Separated/Divorced	4.5 (7)	1.9 (3)	
Smoking			0.47
Never Smokers	73.0 (111)	75.3 (116)	
Former smoker	24.3 (37)	20.1 (31)	
Current smoker (4–20 cigarettes/day)	2.6 (4)	4.6 (7)	
Currently Breast Feeding	96.8 (149)	97.5 (153)	0.75
Regular childcare for infant	43.5 (67)	47.1 (74)	0.57
Type of Delivery			0.18
Vaginal	76.6 (118)	69.4 (109)	
Cesarean	23.4 (36)	29.9 (47)	
Adoption	0	0.6 (1)	
Baby is mobile	25.3 (39)	28.7 (45)	0.53

^a Chi square test for differences in proportions; t test for differences in means

^b For 2 women (1 per group) race/ethnicity was missing/not reported

^c Of the women who reported being Hispanic, 81% were represented in the above listed race categories, for example in the Filipino, Native Hawaiian, or mixed race categories

^d Diagnosed with gestational diabetes in most recent pregnancy

Table 3

Minutes of MVPA/week via survey by time point, study condition and participant characteristics. Honolulu, Hawaii: 2008–2011

	TTCW		SWO		p ^b
	Mean (95% CI) ^a Minutes MVPA		Mean (95% CI) ^a Minutes MVPA		
	Baseline	Month 12	Baseline	Month 12	
Overall MVPA via Survey (n=306)	44 (41, 47)	246 (222, 272)	46 (42, 49)	156 (140, 173)	0.027
Median split of minutes of MVPA (40min) via Survey at Baseline					
< Median	9 (8, 11)	185 (153, 221)	9 (8, 11)	159 (130, 194)	0.13
Median	127 (119, 135)	318 (272, 368)	128 (119, 137)	153 (126, 184)	
Age, years					
< 25	61 (54, 69)	163 (101, 249)	30 (24, 38)	172 (115, 246)	0.27
25–29	51 (45, 58)	315 (257, 381)	44 (38, 52)	166 (132, 207)	
30–34	38 (32, 44)	211 (168, 262)	53 (46, 60)	137 (111, 167)	
35–39	33 (29, 37)	254 (221, 290)	60 (51, 69)	148 (118, 182)	
40	94 (72, 121)	292 (226, 371)	26 (18, 36)	179 (126, 246)	
Race ^c					
Japanese	36 (27, 46)	182 (119, 266)	42 (33, 52)	105 (76, 141)	
Filipino	35 (29, 41)	153 (108, 211)	37 (28, 48)	89 (59, 129)	
Mixed/Other Asian	66 (56, 78)	223 (171, 285)	64 (53, 76)	181 (139, 231)	
Native Hawaiian/ Pacific Islander	41 (37, 45)	237 (202, 275)	48 (42, 55)	164 (134, 199)	
White	64 (54, 75)	412 (328, 511)	38 (32, 43)	191 (157, 230)	

	TTCW		SWO		p ^b
	Mean (95% CI) ^a Minutes MVPA				
	Baseline	Month 12	Baseline	Month 12	
Other Mixed Race	38 (33, 43)	248 (210, 291)	47 (40, 56)	148 (114, 189)	
BMI, kg/m ²					0.93
< 25	39 (35, 44)	265 (229, 305)	50 (43, 58)	196 (165, 232)	
25–29	52 (46, 58)	227 (189, 270)	45 (39, 50)	133 (110, 160)	
30	42 (37, 48)	247 (196, 308)	42 (37, 48)	139 (113, 169)	
Education					0.61
< College graduate	40 (36, 44)	277 (237, 322)	46 (41, 51)	167 (137, 202)	
College graduate	48 (44, 53)	227 (197, 260)	46 (41, 50)	150 (132, 169)	
Employment					0.56
Not paid	47 (43, 52)	305 (267, 347)	53 (46, 60)	187 (155, 223)	
Paid part-time	36 (29, 44)	231 (168, 310)	56 (49, 64)	134 (105, 168)	
Paid full-time	45 (40, 50)	210 (176, 247)	37 (32, 41)	147 (126, 172)	
Number of children					0.016
1 child	50 (45, 56)	175 (145, 209)	49 (43, 55)	207 (177, 242)	
2 or more	41 (37, 44)	302 (268, 339)	44 (40, 49)	133 (116, 152)	
History of gestational diabetes					0.20
Yes	36 (28, 46)	225 (166, 299)	48 (41, 55)	90 (69, 116)	
No/missing	46 (43, 49)	252 (227, 280)	45 (42, 49)	173 (154, 195)	

	TTCW		SWO		p ^b
	Mean (95% CI) ^a Minutes MVPA	Baseline	Month 12	Baseline	
Baby's age, months					0.22
< 3	48 (41, 56)	351 (293, 416)	55 (46, 66)	110 (80, 147)	
3–5	38 (34, 43)	235 (196, 280)	42 (37, 47)	179 (152, 208)	
6–8	48 (41, 55)	178 (141, 222)	47 (37, 58)	171 (135, 213)	
9	49 (39, 60)	202 (147, 271)	46 (39, 55)	136 (104, 174)	
Source of recruitment					0.93
Community	42 (38, 46)	234 (202, 270)	49 (44, 54)	159 (138, 182)	
Kaiser Permanente	47 (43, 52)	265 (229, 304)	42 (37, 47)	153 (129, 181)	

^a Adjusted for age, race, BMI, education, number of children, employment, depression, baby's age, gestational diabetes, recruitment site, years lived in HI. Means and 95% CIs were computed as (X^4-1) , where X represented the means and 95% CIs of the predicted values obtained from the models.

^b Treatment effect was assessed by a mixed growth model and the F test of the fixed 2-way interaction parameter for time and study condition for overall and of the 3-way interaction parameter for characteristic level, time, and study condition. The relevant main and interaction parameters (in units of MVPA minutes + 1, to the 0.25 power) for the overall model are as follows: 0.077 (SE=0.011, $p<0.0001$) for time in months, 0.025 (SE=0.120, $p=0.84$) for condition and 0.036 (SE=0.016, $p=0.027$) for the time and condition interaction.

^c Other group excluded in comparison

Table 4

Minutes of MVPA/week via accelerometer by time, study condition and participant characteristics Honolulu, Hawaii: 2008–2011

	TTCW		SWO		<i>p</i> ^b
	Mean (95% CI) ^a Minutes MVPA		Mean (95% CI) ^a Minutes MVPA		
Overall MVPA at 2.9+ METs via Accelerometer (n=259)	Baseline 163 (153, 174)	Month 12 215 (200, 229)	Baseline 162 (154, 170)	Month 12 203 (189, 217)	0.61
Median split of minutes of MVPA at 2.9+ METs (147 min) via Accelerometer at Baseline					
< Median	111 (105, 117)	209 (190, 227)	108 (102, 113)	172 (153, 189)	0.053
Median	222 (213, 2231)	218 (195, 242)	212 (207, 217)	248 (232, 264)	
Age, years					0.61
< 30	163 (139, 186)	264 (219, 309)	147 (135, 160)	196 (172, 219)	
30–34	183 (165, 201)	200 (175, 224)	167 (152, 182)	191 (158, 224)	
35–39	143 (130, 157)	212 (188, 235)	182 (166, 199)	235 (211, 258)	
40	146 (110, 181)	202 (157, 248)	148 (122, 173)	172 (132, 212)	
Race ^c					0.17
Japanese	147 (122, 172)	196 (159, 233)	164 (146, 182)	177 (146, 208)	
Filipino	194 (175, 214)	210 (176, 245)	170 (139, 201)	232 (130, 186)	
Mixed/Other Asian	174 (158, 190)	202 (181, 223)	172 (145, 198)	215 (166, 264)	
Native Hawaiian/Pacific Islander	158 (130, 186)	177 (117, 236)	152 (135, 170)	202 (178, 226)	
White	171 (138, 204)	228 (188, 269)	167 (149, 185)	239 (199, 279)	
Other Mixed Race	144 (124, 164)	270 (215, 325)	155 (136, 174)	171 (134, 208)	

	TTCW		SWO	
	Mean (95% CI) ^a Minutes		Mean (95% CI) ^a Minutes	
	MVPA		MVPA	
BMI, kg/m ²				0.091
< 25	168 (149, 187)	234 (213, 256)	169 (155, 183)	189 (167, 211)
25–29	156 (142, 170)	207 (183, 232)	155 (140, 171)	232 (206, 258)
30	168 (145, 190)	193 (159, 227)	161 (149, 173)	176 (154, 198)
Education				0.92
< College graduate	167 (148, 187)	190 (162, 217)	150 (135, 164)	173 (138, 209)
College graduate	161 (150, 172)	224 (207, 241)	168 (158, 178)	212 (196, 228)
Employment				0.63
No paid	130 (116, 144)	208 (180, 236)	153 (139, 167)	171 (147, 195)
Paid part-time	200 (161, 238)	191 (140, 241)	176 (154, 198)	215 (180, 249)
Paid full-time	179 (168, 190)	226 (209, 244)	162 (152, 172)	215 (196, 235)
Number of children				0.46
1 child	160 (145, 176)	217 (194, 240)	165 (151, 179)	221 (194, 249)
2 or more	165 (151, 179)	214 (195, 233)	160 (150, 170)	195 (179, 212)
History of gestational diabetes				0.72
Yes	163 (143, 184)	200 (179, 222)	155 (137, 172)	200 (165, 235)
No/missing	163 (151, 175)	219 (201, 237)	163 (154, 172)	203 (187, 219)
Baby's age, months				0.45
< 3	147 (130, 164)	238 (210, 267)	145 (128, 162)	236 (197, 276)

	<u>TTCW</u>		<u>SWO</u>
	Mean (95% CI) ^d Minutes	MVPA	Mean (95% CI) ^d Minutes MVPA
3–5	180 (160, 200)	221 (199, 244)	169 (156, 182) 199 (173, 224)
6–8	150 (127, 172)	200 (165, 235)	172 (152, 162) 198 (162, 233)
9	165 (144, 186)	166 (115, 217)	151 (134, 167) 189 (169, 210)
Source of recruitment			0.85
Community	156 (141, 171)	216 (198, 233)	165 (155, 175) 218 (202, 234)
Kaiser Permanente	174 (159, 181)	214 (188, 239)	158 (144, 171) 181 (155, 207)

^a Adjusted for age, race, BMI, education, number of children, employment, depression, baby's age, gestational diabetes, recruitment site, years lived in HI.

^b Treatment effect was assessed by a mixed growth model and the F test of the fixed 2-way interaction parameter for time and study condition for overall and of the 3-way interaction parameter for characteristic level, time, and study condition. The relevant main and interaction parameters (in units of MVPA minutes) for the overall model are as follows: 3.562 (SE=0.849, $p<0.0001$) for time in months, 0.388 (SE=9.522, $p=0.97$) for condition and 0.648 (SE=1.258, $p=0.61$) for the time and condition interaction.

^c Other group excluded in comparison