The Health-Enhancing Efficacy of Zumba© Fitness: An 8 Week Randomised Controlled Study

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Title

The health-enhancing efficacy of Zumba® fitness: An 8 wk randomised controlled study

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Title

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Abstract

The purpose of this study was to gain a holistic understanding of the efficacy of Zumba® fitness in a community-recruited cohort of overweight and physically inactive women by evaluating i) its physiological effects on cardiovascular risk factors and inflammatory biomarkers and ii) its mental health-enhancing effects on factors of health-related quality of life. Participants were randomly assigned to either engagement in one to two 1 h classes of Zumba® fitness weekly (intervention group; n = 10) or maintenance of habitual activity (control group; n = 10). Laboratory assessments were conducted pre- (wk 0) and post-intervention (wk 8) with anthropometric, physiological, inflammatory, and health-related quality of life data collected. In the intervention group, maximal oxygen uptake significantly increased ($p < 0.05$; partial η^2 = 0.56) by 3.1 mL·kg^{-1}·min^{-1}, percent body fat significantly decreased ($p < 0.05$; partial η^2 = 0.42) by –1.2%, and interleukin-6 and white blood cell count both significantly decreased ($p < 0.01$) by –0.4 pg·mL^{-1} (partial η^2 = 0.96) and –2.1 10^9 cell·L^{-1} (partial η^2 = 0.87), respectively. Large magnitude enhancements were observed in the health-related quality of life factors of physical functioning, general health, energy/fatigue, and emotional well-being. When interpreted in a community-based physical activity and psychosocial health promotion context, our data suggest that Zumba® fitness is indeed an efficacious health-enhancing activity for adults.

Keywords

ActiGraph wGT3X+ accelerometer, Latin dance, leisure-time physical activity, salsa aerobics, SF-36

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Introduction

The salutary effects of regular physical activity (PA) on physical (World Health Organization [WHO], 2010) and mental (Crone, Smith, & Gough, 2006) health are well-established and convincing. Of concern to PA investigators is the fact that half the adult populace remains physically inactive (WHO, 2011). Recent cross-sectional research has demonstrated association between accelerometer-determined PA and improved cardiovascular risk factors (Glazer et al., 2013) and health-related quality of life (HRQoL; Anokye, Trueman, Green, Pavey, & Taylor, 2012). Aerobic dance, a popular type of PA engaged in primarily by women (Zaletel, Gabrilo, & Peric, 2013), has been associated with lowered likelihood of inflammatory biomarker elevation when compared to traditional (i.e., cycling and weight training) exercise (King, Carek, Mainous, & Pearson, 2003). A prospective cohort analysis of ~27,000 women indicated that cardioprotection afforded through PA was mediated largely by inflammatory biomarkers, blood pressure (BP), blood lipids, and body mass index (BMI; Mora, Cook, Buring, Ridker, & Lee, 2007). Recent PA research utilising Zumba® fitness, a specific form of Latin-themed aerobic dance, has shown post-intervention improvements in BP in obese women (Araneta & Tanori, 2014), BMI in overweight women (Barene, Krustrup, Brekke, & Holtermann, 2014), and maximal oxygen uptake (VO_{2max}) in normal weight women (Delextrat, Warner, Graham, & Neupert, 2015).

We recently demonstrated that combined accelerometry and heart rate (HR) telemetry can provide a valid and reliable physiological assessment of Latin dance parameters under laboratory-based (Domene & Easton, 2014) and naturalistic settings in recreational dancers (Domene, Moir, Pummell, & Easton, 2014) and physically inactive women (Domene, Moir, Pummell, & Easton, 2015). It has been reported that Zumba® fitness is currently practised by an estimated 14 million people in over 150 countries (Inouye, Nichols, Maskarinec, & Tseng, 2013), yet minimal evidence from randomised controlled studies (Barene et al., 2014; Donath, Roth, Hohn, Zahner, & Faude, 2014) exists to substantiate its purported health-enhancing efficacy. The physiological effect of Zumba® fitness on change in cardiovascular risk factors and inflammatory biomarkers remains unclear. In adults, as cardiorespiratory fitness is inversely associated with all-cause mortality, irrespective of weight status (Barry et al., 2014), and low-grade systemic inflammation is correlated with both physical (Hamer & Stamatakis, 2009) and psychological ill health (Valkanova, Ebmeier, & Allan, 2013), it is possible that vigorous intensity aerobic PA, such as Zumba® fitness (Domene et al., 2015),

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may indeed be beneficial for improvement of these health outcomes. Furthermore, randomised controlled study evidence to support the potential of Zumba® fitness in enhancing HRQoL over time among community-based physically inactive women is also lacking (Cugusi et al., 2015).

Consequently, we conducted a randomised controlled study of Zumba® fitness in a community-recruited cohort of overweight and physically inactive women, as these individuals are commonly targeted in PA and psychosocial health promotion campaigns. Our primary outcome measure was VO_{2max}, which we hypothesised would increase following attendance in an 8 wk programme of Zumba® fitness. Secondary outcomes included inflammatory biomarkers (C-reactive protein (CRP), interleukin-6 (IL-6), and white blood cell count (WBC)), other cardiovascular risk factors (cholesterol, BP, BMI, and percent body fat (BF)), and HRQoL. We hypothesised that these anthropometric, physiological, and inflammatory measures would decrease, and HRQoL would increase, post-intervention.

Methods

Participants

Rolling recruitment was undertaken using poster advertisements placed in the Royal Borough of Kingston and the surrounding communities of London, UK. The study had been approved by the Faculty Ethics Committee at Kingston University and was conducted in accordance with the Declaration of Helsinki. The participants gave their informed consent in writing before the commencement of the study and after the experimental procedures, risks, and benefits of participation had been explained. Inclusion criteria stated that the participants must be female, aged 18 to 64 yr, physically inactive (≤ 1 day·wk^{-1} of moderate to vigorous PA for no more than 30 min), inexperienced at Zumba® fitness (≤ one class previously attended), overweight (BMI ≥ 25.0 kg·m^{-2}), and free from musculoskeletal injury. Participants were excluded if they were: cigarette smokers; pregnant; recovering from a major injury or illness; or using anti-inflammatory, hyperlipidaemia, or hypertension medication. Between August 2013 and March 2014, a total of 97 women expressed interest in volunteering for the study. Once the full inclusion and exclusion criteria were specified, it was found that 74 of the women were ineligible for enrolment. The remaining 23 consented to enrol in the study and were randomised to either the intervention or control group using a random number generator. The participants began the study within 2 wk following randomisation. After commencement, one control and two intervention participants withdrew from the study due to

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unavoidable work commitments or unspecified illness. The two intervention participants attended two and four of the 12 required Zumba® fitness classes, but were excluded from the data analysis. The final sample therefore comprised 20 women.

Study design

A two group randomised controlled study was employed with measures taken at pre- (wk 0) and post-intervention (wk 8). Laboratory assessments were conducted prior to and following an 8 wk period of attendance in classes of Zumba® fitness (intervention) or habitual activity (control) with anthropometric, physiological, inflammatory, and HRQoL measures recorded.

Laboratory procedure

The participants visited the laboratory at 9:00 a.m. following an overnight fast and were instructed to arrive in a euhydrated state. After 15 min of seated rest, resting HR and BP were measured using an automated monitor (Elite 7300IT, Omron Healthcare Inc, USA). Stature was determined with a stadiometer (213, Seca Ltd, UK) and body mass and BF were assessed using a multifrequency bioelectrical impedance analyser (MC 180MA, Tanita Europe BV, Netherlands). BF measurements from this analyser have been significantly correlated with measurements taken using dual energy X-ray absorptiometry (Leahy, O'Neill, Sohun, & Jakeman, 2012). Venous blood samples were then obtained by a trained phlebotomist. WBC was measured using an automated haematology analyser (Micros, Horiba ABX SAS, France). The whole blood was then centrifuged at room temperature for 10 min at 2000 rev·min^{-1}. Cryovials containing extracted plasma and serum were frozen at –80°C. CRP was measured in plasma using a sandwich enzyme-linked immunosorbent assay (EL10022, Bio Supply Ltd, UK) and plasma IL-6 was measured using a high-sensitivity sandwich enzyme-linked immunosorbent assay (HS600B, R&D Systems Europe Ltd, UK). Serum total cholesterol and high-density lipoprotein cholesterol were measured using a semi-automated chemistry analyser (RX Monza, Randox Laboratories Ltd, UK) with assay kits provided by the manufacturer. A graded treadmill exercise test, as described previously (Domene et al., 2014), was then performed for determination of VO$_{2max}$ and maximal HR. Briefly, following a 3 min warm-up of level walking at 2.7 km·h^{-1}, the Bruce protocol was used until volitional exhaustion with HR measured via radio telemetry (RS400, Polar Electro Oy, Finland) and breath-by-breath pulmonary gas exchange data collected using an indirect calorimeter (Oxycon Pro, Viasys Healthcare GmbH, Germany). Instructions were given to all participants to refrain from engagement in other exercise for the duration of the study

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period. The participants were then familiarised with the instruments for the study, instructed on their

proper usage, and administered the RAND 36-Item Health Survey 1.0 (SF-36; Hays, Sherbourne, &

Mazel, 1993) for evaluation of HRQoL.

Instruments

A triaxial accelerometer (wGT3X+ 2.2, ActiGraph LLC, USA) was worn on the right wrist (Domene

& Easton, 2014), along with the manufacturer's accompanying chest strap HR monitor, and was

initialised for data recording as described previously (Domene et al., 2014). Downloading of the HR

and vector magnitude acceleration data was undertaken using 1 s epochs and with the low frequency

extension enabled. The utility of this equipment for dance has been described previously (Domene et

al., 2014). For the SF-36, satisfactory internal consistency has been reported for the factors of

physical functioning, role limitations due to physical health, pain, general health, energy/fatigue, social

functioning, role limitations due to emotional problems, and emotional well-being (Hays et al., 1993).

Intervention

Participants in the intervention group took part in 12 classes of Zumba® fitness over an 8 wk

period. A frequency of one weekly class was attended during the first half of the intervention, followed

by a progression to two weekly classes during the second. The choice of one weekly class was made

as the participants were inexperienced at this specific form of Latin-themed aerobic dance and we

wanted to safely incorporate a progression in weekly volume over the course of the intervention.

Attendance in two weekly sessions of Zumba® fitness has been demonstrated (Domene et al., 2015)

to meet the WHO recommendation (WHO, 2010) for vigorous aerobic PA necessary for the

maintenance of health. Accelerometry and HR data were collected during all sessions. The instructor-

led group-based classes were taught by certified Zumba® fitness teachers in established venues in

the Royal Borough of Kingston and the surrounding communities of London, UK. All teachers were

current members of the Zumba® Instructor Network. Each class was 1 h in length and a recovery

period of at least 48 h was taken between classes. Instructions were given to perform euhydrated and

at least 2 h postprandial. The Zumba® fitness venues and scheduling of sessions were self-selected

by the participants and were chosen to be representative of where and when they might normally

attend classes of aerobic dance for exercise purposes. The content of a typical Zumba® fitness class

has been described previously (Domene et al., 2015). Participants in the control group maintained

their habitual activity for the duration of the study period.

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Data analysis

Calculations of total energy expenditure (EE), total step count (SC), HR reserve (HRR), and metabolic equivalents (MET) during Zumba® fitness were undertaken using the mean of the data collected during the dance classes. HRR was formulated using previously described methods (Domene et al., 2015) and the combined accelerometry and HR data were processed with a previously described dance-specific cut-point and prediction equation technique (Domene & Easton, 2014). An a priori sample size computation was performed using the primary outcome measure of VO_{2max}. Based on our previous work (Domene et al., 2015), VO_{2max} mean ± standard deviation was input as 30.5 ± 4.7 mL·kg^{-1}·min^{-1} with an expected post-intervention improvement of 15.6% (WIlliams & Morton, 1986). It was shown that a between-group comparison with 70% power would require 10 participants per group. Statistical analyses were conducted using the programming language R (R 3.0, The R Foundation for Statistical Computing, Austria). Differences between groups in pre-intervention anthropometric, physiological, and inflammatory measures and pre-intervention HRQoL factors were ascertained using independent *t*-tests. Pre- and post-intervention differences in anthropometric and physiological measures were explored using repeated measures analysis of covariance (RM-ANCOVA) with pre-intervention scores selected as covariates. Inflammatory biomarkers were assessed pre- and post-intervention using RM-ANCOVA with pre-intervention scores, VO_{2max}, and BF selected as covariates (Hamer, 2007). RM-ANCOVA was also used to determine differences across time in HRQoL factors. The pre-intervention score was selected as the covariate in the models. Relationships between anthropometric, physiological, and inflammatory measures and HRQoL factors were investigated using Pearson's correlation coefficients. Alpha was set at 0.05. Centrality and spread are presented as mean ± standard deviation with 95% confidence intervals (CI) reported where appropriate.

Results

Missing data

Two intervention participants missed a single Zumba® fitness session each; the average rate of attendance for this study was therefore 98%. Blood draw by venipuncture was unsuccessful in three intervention and five control participants due to either the maximum number of attempts (two) permitted in our laboratory for research purposes being reached, or consent for venipuncture being

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withdrawn. These participants were therefore excluded from the data analysis of cholesterol and inflammatory biomarkers.

Pre-intervention anthropometric, physiological, and inflammatory measures

Results of the between-group comparison of anthropometric, physiological, and inflammatory measures taken at pre-intervention are presented (Table I). No pre-intervention differences (all $p > 0.05$) were observed between groups in all measures assessed.

Responses during Zumba® fitness

The Zumba® fitness sessions elicited an exercise intensity of 6.73 ± 0.24 MET and a HRR of 51.1 ± 15.6%. It was revealed that total EE and total SC were 410 ± 70 kcal and 6681 ± 674 step, respectively, during the 1 h classes.

Pre- to post-intervention changes in anthropometric, physiological, and inflammatory measures

Results of the pre- to post-intervention assessment of changes in anthropometric, physiological, and inflammatory measures are presented (Table II). A significant main effect of time was obtained for BF ($p < 0.05$; partial $\eta^2 = 0.42$), VO$_{2max}$ ($p < 0.05$; partial $\eta^2 = 0.56$), IL-6 ($p < 0.01$; partial $\eta^2 = 0.96$), and WBC ($p < 0.01$; partial $\eta^2 = 0.87$) for intervention participants. No other differences (all $p > 0.05$) in anthropometric, physiological, and inflammatory measures were found.

Evaluation of HRQoL

During the laboratory visits, all participants completed all questions on the SF-36; the response rate for this study was therefore 100%. No pre-intervention differences (all $p > 0.05$) were observed between groups in the HRQoL factors assessed. Results of the comparison of HRQoL scores across time are presented (Table III). A significant main effect of time was obtained for physical functioning ($p < 0.01$; partial $\eta^2 = 0.57$), general health ($p < 0.01$; partial $\eta^2 = 0.60$), energy/fatigue ($p < 0.01$; partial $\eta^2 = 0.55$), and emotional well-being ($p < 0.001$; partial $\eta^2 = 0.63$) for intervention participants. No other differences (all $p > 0.05$) in HRQoL were found.

Correlation between anthropometric, physiological, and inflammatory measures and HRQoL factors

Results of the correlation analyses between pre- to post-intervention changes in the HRQoL general health factor and BF and VO$_{2max}$ in the intervention group are presented (Figures 1 and 2, respectively). No other associations (all $p > 0.05$) between the anthropometric, physiological, and inflammatory measures and HRQoL factors were revealed in either the intervention or control group.

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Discussion

Attendance in one to two 1 h classes of Zumba® fitness over an 8 wk period modestly improved VO_{2max}, body composition, and inflammatory biomarkers relevant to cardiovascular health in overweight and physically inactive women with little or no previous experience in Latin-themed aerobic dance. Moreover, large magnitude (Richardson, 2011) pre- to post-intervention enhancements in HRQoL were observed for the factors of physical functioning, general health, energy/fatigue, and emotional well-being. No differences were found in any of the evaluated outcomes for control participants. Hence, the current work demonstrates that a community-recruited cohort of individuals undertaking dance-related PA in a naturalistic setting can indeed improve measures of both physical and mental health. The relevance of these findings, in terms of gaining a holistic understanding of the efficacy of this particular activity, should not be underestimated considering the current (Inouye et al., 2013), and likely growing, popularity of Zumba® fitness in both Latin and non-Latin communities.

The physiological demand of the Zumba® fitness classes, when expressed as an average MET value across the intervention, was higher in the current work in comparison to our previous finding (Domene et al., 2015). This discrepancy is likely due to the current participants having a higher BMI and lower VO_{2max} than those previously recruited. As the MET value of PA is a measure of EE relative to body mass (where 1 MET = 1 $kcal \cdot kg^{-1} \cdot h^{-1}$ of energy expended), it is plausible that adults taking part in aerobic dance who are overweight or obese might, on the whole, have a higher MET value during participation than their normal weight counterparts. Moreover, as the current participants had a lower VO_{2max}, it is possible that the relative intensity of Zumba® fitness experienced was higher than in those who took part in our earlier work. It is known that the physiological responses to aerobic dance are affected by several factors (Clapp & Little, 1994), including fitness, such that those with a low VO_{2max} work at a higher relative intensity than those with a high VO_{2max}. The presented results, along with our previous findings (Domene et al., 2015), and when considering the work of others where adults of both sexes and different fitness levels, ages, and previous experience in Zumba® fitness were recruited (Luettgen, Foster, Doberstein, Mikat, & Porcari, 2012; Sternlicht, Frisch, & Sumida, 2013), taken together, support the notion that Zumba® fitness is best categorised as a vigorous, not a moderate, intensity activity. This may explain why Zumba® fitness participants demonstrate a higher prevalence of class-related injuries with increasing class frequency (beyond three sessions weekly),

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even after adjustment for age, sex, and previous Zumba® fitness experience (Inouye et al., 2013). Of note, a recent 16 wk investigation of Zumba® fitness indicated that of the 13 participants that did not complete the intervention, 10 cited the strenuousness of the activity or having experienced class-related injury/pain as reason for withdrawal from the research; the volume of classes used was three sessions weekly (Krishnan et al., 2015). It may therefore be prudent for future researchers of Zumba® fitness to consider utilising a progressive approach in terms of weekly volume, as was employed in the present study, when evaluating this particular form of aerobic dance.

It was reported that vigorous intensity PA increased following a six month Latin-themed aerobic dance intervention with minutes of PA being self-reported via questionnaire (Hovell et al., 2008). Lee, Mama, Medina, Orlando Edwards, and McNeill (2011), on the other hand, used both subjective and objective techniques and also reported increased PA of a moderate intensity following a 4 wk Latin dance intervention. In a recent 12 wk investigation of Latin dance, again using simultaneous subjective and objective methods for the assessment of PA, it was reported that questionnaire results indicated increased total PA minutes post-intervention; however, no increase was revealed when PA was evaluated using accelerometry (Marquez, Bustamante, Aguinaga, & Hernandez, 2014). This discrepancy not only confounds the issue of whether dance interventions are efficacious in terms of increasing dance-related PA, but also highlights the need for using activity-specific accelerometer data processing techniques. The conversion of accelerometer counts in the research of Marquez et al. (2014) was undertaken using cut-points calibrated on a treadmill. This method has now been shown to be invalid for the processing of accelerometer data collected during dance (Domene & Easton, 2014) and may explain the reported discrepancy between the two aforementioned outcome measures.

Forty weeks of Zumba® fitness attended two to three times weekly increased VO_{2max} and decreased BF by 2.2 mL·kg^{-1}·min^{-1} and −1.3%, respectively (Barene et al., 2014). These improvements are similar to the results presented in the current research, despite weekly volume of classes and total intervention length being greater in the work of Barene et al. (2014). A larger increase in VO_{2max} (~5 mL·kg^{-1}·min^{-1}) and smaller decrease in BF (~−0.6%) were observed consequent to six months of Latin-themed aerobic dance undertaken three times weekly (Hovell et al., 2008) and 4 wk of Latin dance undertaken twice weekly (Lee et al., 2011), respectively. These interventions, along with the current work, were conducted using primarily community-recruited

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female participants. We would argue that this is a reasonable representation of individuals who actually attend instructor-led group-based classes of aerobic dance under real (i.e., non-research-related) conditions (Zaletel et al., 2013). In the present study, we demonstrated only modest improvements in VO_{2max} and body composition, with no concomitant change in BMI. Whether dance-related PA programmes are effective (Barene et al., 2014; Krishnan et al., 2015) or ineffective (Araneta & Tanori, 2014; Hovell et al., 2008) for lowering BMI in community-based adult cohorts remains an unresolved issue in the literature. Regardless, improved VO_{2max} and body composition through regular PA has been associated with enhanced health outcomes and decreased cardiovascular risk factors in adults, irrespective of weight loss (Ross & Janiszewski, 2008).

Although the current work is the only research we are aware of that has investigated inflammatory responses to Latin-themed aerobic dance, King et al. (2003) demonstrated association between aerobic dance participation and reduced likelihood of inflammatory biomarker elevation. Specifically, after adjustment for age, sex, race, BMI, and smoking and health status, odds ratios for CRP and WBC were 0.31 [95% CI 0.13 to 0.78] and 0.11 [95% CI 0.03 to 0.41], respectively, for adults taking part in 12 or more classes monthly when compared to engagement in 11 classes or less. It was suggested by the investigators that participation in aerobic dance may be more beneficial in terms of moderating inflammatory biomarkers relevant to cardiovascular health than other types of PA; however, when interpreting these findings it needs to be considered that objective measures of PA, including intensity and time parameters, which we would argue are necessary for a comprehensive comparison of different PA types, were not collected in this study. Okita et al. (2004) examined participants before and after two months of engagement in supervised PA involving twice weekly sessions of aerobic dance combined with traditional aerobic exercise. The weekly volume of PA (~4 h) was substantially higher than the volume used in the current research. CRP decreased to a similar degree as that reported in the present study (35 versus 42%), whilst WBC was also reduced, although to a smaller degree than that observed in this investigation (8 versus 31%). In a study comparing different PA domains (Autenrieth et al., 2009), it was demonstrated that participation in increasing intensities of leisure (but not specifically dance-related) PA was negatively correlated with IL-6. However, in the same study it was also shown that no relationship existed between leisure PA and CRP after adjustment for all potential confounding factors. Further highlighting the inconsistencies in the literature, LeCheminant, Tucker, and Russell (2011) collected objective PA data and reported that

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accelerometer counts were negatively correlated ($p < 0.05$) with CRP. When adjusted for BMI, the relationship weakened ($p = 0.08$), and when adjusted for BF (a measure not recorded in any of the aforementioned studies of inflammatory status), total PA no longer predicted ($p = 0.73$) CRP. It is possible that the discrepancies in the literature in regards to the likely anti-inflammatory properties of regular PA may be explained by BF, which has been suggested to be a more sensitive measure than BMI when accounting for potential confounding factors related to PA and inflammatory status (LeCheminant et al., 2011). Indeed, in a review evaluating 40 observational and 12 randomised controlled studies, the roles of both BF and fitness were assessed in the context of PA and its relationship with inflammatory biomarkers (Hamer, 2007). It was suggested that BF, fitness, and inflammatory biomarkers may be associated in such a way that i) the inflammatory biomarker and fitness relationship could either be confounded or mediated by BF, or, that ii) fitness and BF might possibly share the same causal pathways. Despite the inconclusive evidence, we would suggest that PA specialists ought to promote the importance of improving both fitness and body composition in adults through increased regular PA. Moreover, in terms of demonstrable health effects of Zumba[®] fitness, it might be warranted to promote this activity for cardioprotective purposes, specifically in terms of being able to reduce low-grade systemic inflammation through PA and, thus, improve one's cardiovascular risk profile (Mora et al., 2007; Plaisance & Grandjean, 2006), instead of focussing on goals oriented towards weight loss.

Higher levels of PA have been associated with better HRQoL in adults (Anokye et al., 2012); however, the current work is the only randomised controlled study we are aware of to have specifically tested the hypothesis that dance affects HRQoL, as measured by the SF-36, in a positive fashion. In an 8 wk Zumba[®] fitness intervention (Donath et al., 2014), change in quality of life was determined using the WHO Quality of Life questionnaire. It was demonstrated that those assigned to classes of Zumba[®] fitness twice weekly improved their quality of life score post-intervention with a large magnitude effect (partial $\eta^2 = 0.45$). In the current study, four of the eight factors of the SF-36 resulted in improved values post-intervention; the average effect was similar in magnitude (partial $\eta^2 = 0.59$) to that reported by Donath et al. (2014). As the Zumba[®] fitness classes in the current research were group-based, it is possible that engagement may have fostered feelings of social connectedness between the participants and the other individuals taking part in the class at the same time (Tarr, Launay, & Dunbar, 2014). Consequently, a sense of camaraderie may have been experienced, which

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we would argue would likely be assistive in terms of exercise adherence (Ryan, Williams, Patrick, & Deci, 2009). Moreover, we would argue that musical accompaniment is central to most, if not all, genres of dance, including aerobic dance. In a recent review (Tarr et al., 2014), the biological mechanisms underlying the proposed social bonding effect of music during synchronised group-based rhythmic activities were described. It is possible that some of these factors may have contributed to the improved HRQoL observed in the current work. Interestingly, we also found associations between change in the HRQoL general health factor and change in both BF and VO_{2max}. As Zumba® fitness is a vigorous intensity activity (as discussed earlier), and taking into account the fact that the participants were physically inactive and of moderately low fitness, it is plausible to assume that our intervention provided sufficient stimulus to simultaneously impart both physical and mental health gains. Sports and exercise (i.e., swimming, running, cycling, gym-based exercise, and team sports), and walking, as PA types, have been previously correlated with modest effects on HRQoL (Anokye et al., 2012). The current work adds to the literature by demonstrating that Latin-themed aerobic dance is related to enhanced feelings of general health when VO_{2max} and body composition are improved. Although the biological mechanisms to explain this are complex and remain unclear, it is probable that promotion of a reduced anti-inflammatory state, optimisation of neuroendocrine and physiological stress response systems, and/or enrichment of neuroplasticity and growth factor expression are involved (Silverman & Deuster, 2014). These may be contributing factors in terms of the beneficial health effects of regular PA consistently reported in adults (WHO, 2010).

The current investigation has several strengths worth noting. These include the recruitment of an ecologically valid sample of participants (which is in contrast to previous assessments of Zumba® fitness; Sternlicht et al., 2013), the use of objectively measured PA and dance-specific accelerometer data processing techniques (again, in contrast to previous Zumba® fitness studies; Araneta & Tanori, 2014), and the use of a naturalistic (i.e., self-selected) environment in which the dance-related data were collected (also in contrast to previous PA interventions utilising Zumba® fitness; Krishnan et al., 2015). There are also some limitations that warrant highlighting. Firstly, we cannot rule out selection bias in this study in terms of participant preference for Latin music and/or dance. There is indeed a possibility that the individuals who enrolled in this research were already aware that they enjoyed listening to Latin music or even being involved in dance outside of an exercise context (i.e., social gatherings). This limitation may have affected the representativeness of our participants within the

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total number of overweight and physically inactive women in the community from which we sampled. Secondly, this study made use of only a habitual activity control condition against which the intervention participants were compared. We acknowledge that it would be more informative and perhaps more practical to compare the efficacy of this non-traditional exercise form with traditional modalities, such as running or weight training, using a three group randomised controlled study design. However, when this research was initially planned, no randomised controlled studies of Zumba® fitness had yet been published and we felt it was justified to employ a study design with two groups only. Thirdly, we understand our results could have been confounded by the fact that the intervention participants undertook their classes in different Zumba® fitness venues (and therefore with different teachers) from each other. Although we made attempts to control for this by verifying that all sessions attended were taught by current Zumba® Instructor Network members in established venues listed on the official Zumba® fitness website, it is plausible to assume that differences in physical location and instructor style may have affected the intensity of the choreographies taught and, thus, the training stimulus experienced.

In conclusion, using a randomised controlled study design, we demonstrated that Zumba® fitness is beneficial for improving cardiovascular risk factors and inflammatory biomarkers, and for enhancing HRQoL in a cohort of overweight and physically inactive women. We would argue that these findings are generalisable to other similar cohorts of women (i.e., those moderately low in fitness, inexperienced in dance, non-exercising, and of a comparable age and weight status). When interpreted in a community-based PA and psychosocial health promotion context, our data suggest that Zumba® fitness is indeed an efficacious health-enhancing activity for adults.

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Tables

Table I. Between-group comparison of anthropometric, physiological, and inflammatory measures prior to 8 wk of engagement in Zumba® fitness (intervention group; *n* = 10) or maintenance of habitual activity (control group; *n* = 10) in a community-recruited cohort of overweight and physically inactive women.

	Total	Intervention	Control	*p*
Anthropometric				
Age (yr)	34 ± 12	33 ± 11	35 ± 13	0.80
Body mass (kg)	70.6 ± 5.9	69.9 ± 4.9	71.4 ± 7.0	0.59
BMI (kg·m^{-2})	27.1 ± 1.9	26.7 ± 1.7	27.6 ± 2.0	0.30
BF (%)	31.3 ± 5.5	30.9 ± 5.5	31.7 ± 5.8	0.76
Physiological				
VO$_{2max}$ (mL·kg^{-1}·min^{-1})	28.7 ± 6.2	29.4 ± 5.9	28.0 ± 6.7	0.61
Mean arterial BP (mmHg)	90 ± 8	89 ± 8	91 ± 9	0.71
TC to HDL-C ratio	4.1 ± 1.5	4.2 ± 1.2	4.0 ± 1.8	0.89
Inflammatory				
CRP (mg·L^{-1})	1.5 ± 0.8	1.2 ± 1.0	1.7 ± 0.5	0.26
IL-6 (pg·mL^{-1})	1.2 ± 0.4	1.1 ± 0.5	1.3 ± 0.3	0.64
WBC (10^9 cell·L^{-1})	6.3 ± 1.7	6.7 ± 1.8	5.8 ± 1.4	0.36

Notes: Data are presented as mean ± standard deviation; BF, percent body fat; BMI, body mass index; BP, blood pressure; CRP, C-reactive protein; HDL-C, high-density lipoprotein cholesterol; IL-6, interleukin-6; TC, total cholesterol; VO$_{2max}$, maximal oxygen uptake; WBC, white blood cell count.

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Table II. Comparison of pre- to post-intervention changes in anthropometric, physiological, and inflammatory measures following 8 wk of engagement in Zumba® fitness (intervention group; n = 10) or maintenance of habitual activity (control group; n = 10) in a community-recruited cohort of overweight and physically inactive women.

	Intervention			Control		
	Change	95% CI	p	Change	95% CI	p
Anthropometric						
Body mass (kg)	–0.5	–1.4 to 0.4	0.25	–0.1	–0.4 to 0.2	0.30
BMI (kg·m^{-2})	–0.2	–0.5 to 0.1	0.22	–0.1	–0.2 to 0.1	0.31
BF (%)	–1.2	–2.3 to –0.1	< 0.05 *	0.0	–0.6 to 0.7	0.88
Physiological						
VO$_{2max}$ (mL·kg^{-1}·min^{-1})	3.1	0.9 to 5.3	< 0.05 *	–0.7	–2.0 to 0.5	0.22
Mean arterial BP (mmHg)	–1	–6 to 4	0.65	0	–3 to 3	0.81
TC to HDL-C ratio	–0.3	–1.0 to 0.5	0.41	0.1	–1.2 to 1.4	0.79
Inflammatory						
CRP (mg·L^{-1})	–0.5	–1.0 to 0.0	0.05	0.1	–1.3 to 1.5	0.82
IL-6 (pg·mL^{-1})	–0.4	–0.5 to –0.3	< 0.01 *	0.1	–0.4 to 0.6	0.65
WBC (10^{9} cell·L^{-1})	–2.1	–3.0 to –1.2	< 0.01 *	–0.5	–1.3 to 0.3	0.15

Notes: BF, percent body fat; BMI, body mass index; BP, blood pressure; CI, confidence interval; CRP, C-reactive protein; HDL-C, high-density lipoprotein cholesterol; IL-6, interleukin-6; TC, total cholesterol; VO$_{2max}$, maximal oxygen uptake; WBC, white blood cell count.
* Significantly different from pre- to post-intervention.

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Table III. Comparison across time of HRQoL factors assessed using the SF-36 during 8 wk of engagement in Zumba® fitness (intervention group; *n* = 10) or maintenance of habitual activity (control group; *n* = 10) in a community-recruited cohort of overweight and physically inactive women.

	Pre-intervention	Post-intervention
Physical functioning		
Intervention	87.0 ± 13.9	95.6 ± 11.7 *
Control	84.9 ± 15.6	82.4 ± 16.9
Role limitations due to physical health		
Intervention	91.1 ± 17.5	92.5 ± 16.9
Control	91.6 ± 16.7	94.1 ± 15.8
Pain		
Intervention	90.8 ± 14.3	89.5 ± 13.4
Control	88.9 ± 17.9	85.5 ± 18.6
General health		
Intervention	68.5 ± 15.7	78.1 ± 13.4 *
Control	66.4 ± 17.8	62.5 ± 17.3
Energy/fatigue		
Intervention	62.5 ± 15.5	78.0 ± 14.8 *
Control	63.5 ± 14.4	64.0 ± 13.7
Social functioning		
Intervention	90.0 ± 13.9	89.1 ± 15.5
Control	87.5 ± 16.4	84.5 ± 19.2
Role limitations due to emotional problems		
Intervention	83.3 ± 16.3	87.3 ± 15.1
Control	83.9 ± 18.7	82.4 ± 19.3
Emotional well-being		
Intervention	77.2 ± 13.7	86.4 ± 11.6 *
Control	76.2 ± 14.6	76.6 ± 11.1

Notes: Data are presented as mean ± standard deviation; HRQoL, health-related quality of life; SF-36, RAND 36-Item Health Survey 1.0.

* Significantly different from pre-intervention at *p* < 0.05.

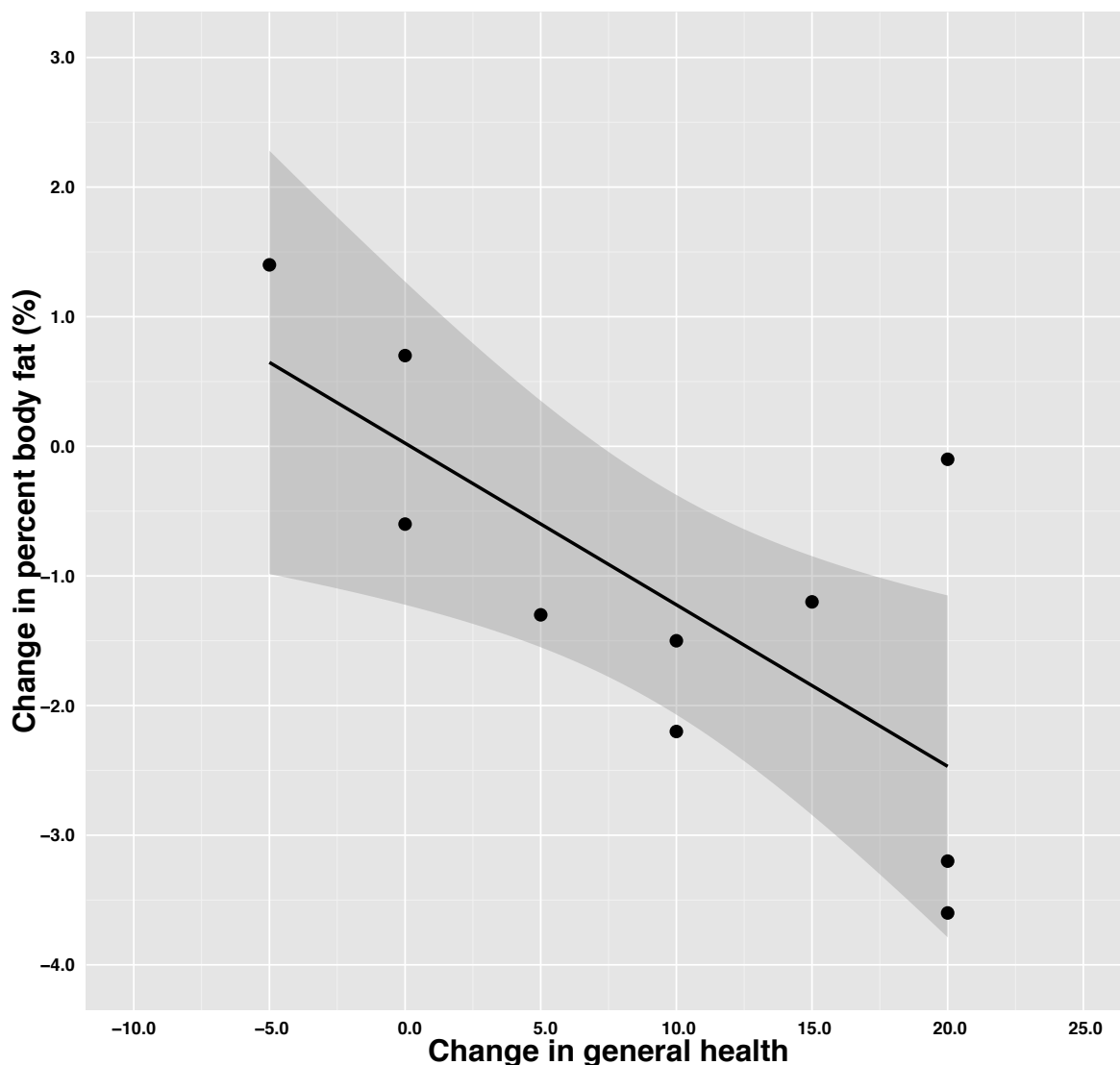Corresponding author: Pablo A Domene (domenep@gmail.com)

Figure 1

Figure 1. Significant negative relationship ($r = -0.73$, $p < 0.05$) between pre- to post-intervention changes in percent body fat and the health-related quality of life general health factor in the intervention group ($n = 10$); Pearson's correlation with 95% confidence intervals are shown.

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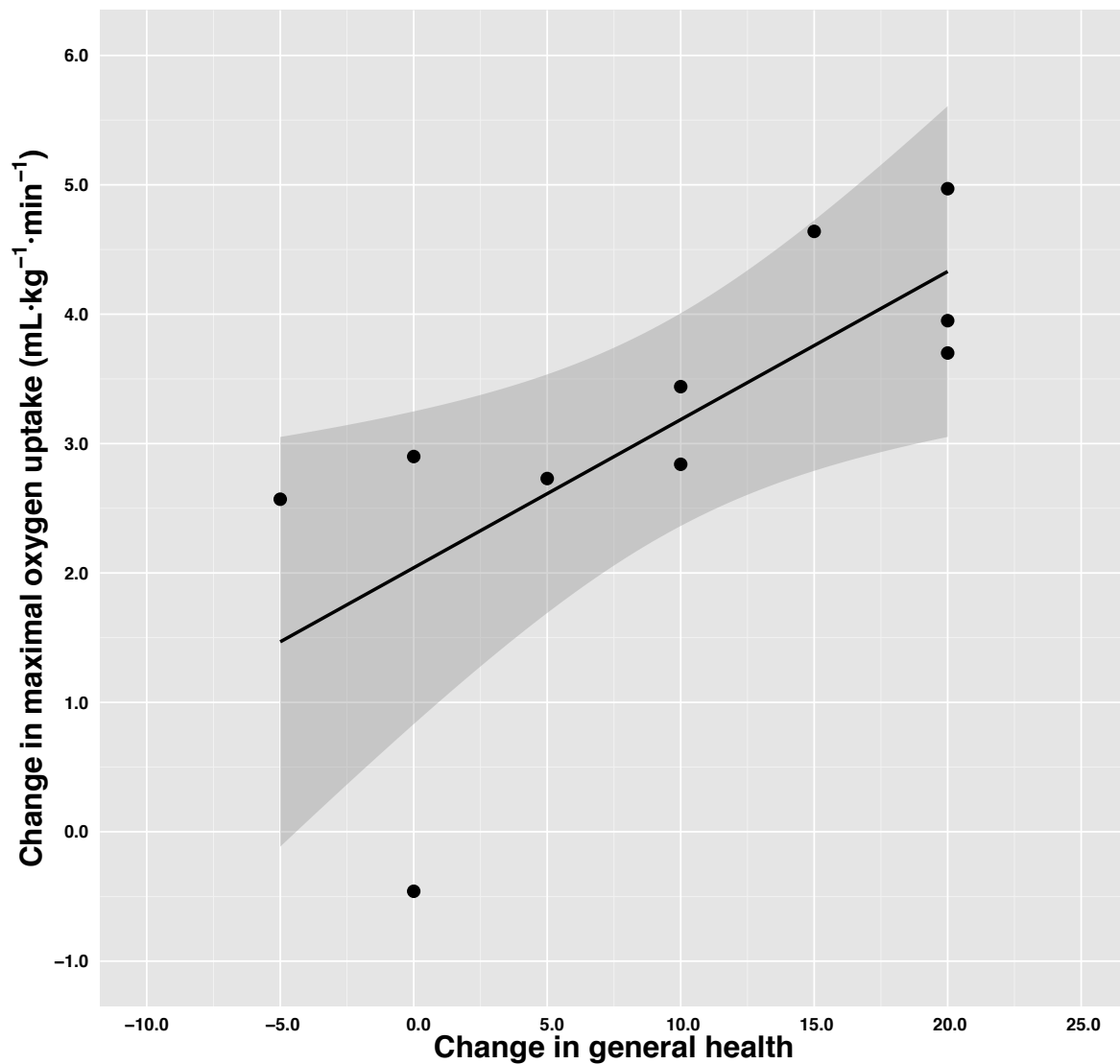Corresponding author: Pablo A Domene (domenep@gmail.com)

Figure 2

Figure 2. Significant relationship (r = 0.71, p < 0.05) between pre- to post-intervention changes in maximal oxygen uptake and the health-related quality of life general health factor in the intervention group (n = 10); Pearson's correlation with 95% confidence intervals are shown.