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Original

# The physiological effects of a low-impact Bodyattack™ class

S. Dias[a], X. Melo[b,c,d], M. Carrolo[b], N. Pimenta[b,d], H. Santa-Clara[b]

[a] *Faculdade de Motricidade Humana. Universidade de Lisboa. Portugal.*
[b] *Centro Interdisciplinar de Estudo da Performance Humana. Faculdade de Motricidade Humana. Universidade de Lisboa. Portugal.*
[c] *GCP Lab. Ginásio Clube Português. Lisboa. Portugal.*
[d] *Escola Superior de Desporto de Rio Maior. Instituto Politécnico de Santarém, Desporto, Condição Física e Saúde. Rio Maior. Lisboa.*

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ABSTRACT

*Objective:* To estimate total energy expenditure and intensity of a low impact Bodyattack™ session using combined heart rate and movement sensing technology.
*Method:* Participants were 10 (8 males) normal-weight adults (33 ± 3 years-old). Maximal oxygen capacity and heart rate were determined by the performance on a treadmill maximal exercise test using indirect calorimetric method. Heart rate and energy expenditure values were monitored during a Bodyattack™ routine using a combined heart rate and movement sensor. The manufacturer's combined activity and heart rate algorithm was used to estimate Total and Physical activity energy expenditure.
*Results*: A 60 min low impact Bodyattack™ session demands a Total energy expenditure of 469.4 ± 170.8 kcal at an average intensity of 64% of maximal heart rate, from which approximately 27.2 min are spent at moderate to vigorous physical activity intensities. Compared to a high impact Bodyattack™ session as reported by the trademark company, Total energy expenditure was lower in the low impact option (-194.8 Kcal, p=0.006), but no significant differences were found in average intensity (-9.4%, p=0.707).
*Conclusion:* Bodyattack™ routines performed at a low impact option may be sufficient to meet minimal recommendations for developing and maintaining cardiorespiratory fitness, if practiced beyond three days.week$^{-1}$. Although appropriate for untrained individuals and those with orthopedic limitations, energy requirements of low impact Bodyattack™ may not be enough to elicit an effective weight loss.
*Keywords:* Energy expenditure; Exercise intensity; Heart Rate; Aerobic dance; Accelerometry.

## Caracterización fisiológica de una clase de Bodyattack ™ de bajo impacto

RESUMEN

*Objetivo:* Estimar el gasto total de energía y la intensidad de una rutina de Bodyattack™ de bajo impacto.
*Métodos:* Los participantes fueron 10 adultos de peso normal (33 ± 3 años). La potencia máxima de oxígeno y la frecuencia cardíaca (FC) se determinaron por el rendimiento en una prueba de ejercicio máxima utilizando el método calorimétrico indirecto. Los valores de la frecuencia cardíaca y del gasto total de energía se monitorearon durante una rutina utilizando un sensor combinado de frecuencia cardíaca y movimiento.
*Resultados:* Una clase de Bodyattack™ de bajo impacto de 60 minutos exige un gasto total de energía de 469.4 ± 170.8 kcal a una intensidad promedio del 64% de la frecuencia cardíaca máxima, de los cuales 27.2 minutos se gastan en actividad física de intensidad moderada a vigorosa. En comparación con una clase de alto impacto, el gasto total de energía fue menor en la opción de bajo impacto (-194.8 Kcal, p=0.006), pero no se encontraron diferencias en la intensidad promedio (-9.4%, p=0.707).
*Conclusión:* Las clases de Bodyattack™ de bajo impacto pueden cumplir con las recomendaciones mínimas para desarrollar y mantener la aptitud cardiorrespiratoria, si se practican más de tres días por semana. Sin embargo, los requisitos de energía de Bodyattack ™ de bajo impacto pueden no provocar una pérdida de peso efectiva.
*Palabras Clave:* Gasto energético; Intensidad de ejercicio; Frecuencia Cardíaca; Danza aeróbica; Acelerometría.

∗ Corresponding author.
E-mail-address: xaviermelo@fmh.ulisboa.pt (X. Melo).

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## Caracterização fisiológica de uma aula de Bodyattack™ de baixo impacto

RESUMO

*Objetivo:* Estimar o dispêndio energético total (DE) e a intensidade de uma aula de Bodyattack™ de baixo impacto.
*Método:* Dez adultos com peso normal (33 ± 3 anos) participaram neste estudo. O consumo máximo de oxigênio e a frequência cardíaca (FC) foram determinadas por calorimetria indireta em resposta a um teste de esforço máximo. A FC e o dispêndio energético total foram monitorizados continuadamente durante a aula usando um sensor combinado de FC e movimento.
*Resultados:* Uma aula de 60 minutos de Bodyattack™ de baixo impacto solicita um dispêndio energético total de 469.4 ± 170.8 kcal a uma intensidade média de 64% da FC máxima, dos quais 27.2 minutos são gastos em atividades físicas de intensidade moderada a vigorosa. Em comparação com uma rotina de alto impacto, o dispêndio energético total foi menor na opção de baixo impacto (194.8 Kcal, p = 0.006), mas não foram encontradas diferenças na intensidade média (-9.4%, p = 0.707).
*Conclusão:* As aulas de Bodyattack™ de baixo impacto podem alcançar as recomendações mínimas para o aumento e manutenção da aptidão aeróbia, desde que praticadas tres ou mais dias por semana. No entanto, o dispêndio energético total de uma aula de Bodyattack™ de baixo impacto pode não concorrer para uma perda de peso efetiva.
*Palavras Chave:* Dispêndio energético; Intensidade do exercício; Frequência Cardíaca; Danza aeróbica; Acelerometria.

## Introduction

Bodyattack™ by The Les Mills International Limited is probably the most widely available aerobic dance program, with high-energy interval training classes combining sports-inspired athletic aerobic movements with strength and stabilization exercises. Instructors have two impact options (low and high) to level up each workout to the individual's capabilities, regarding that high-impact modalities generally cause significantly more debilitating injuries to beginners and to long-term exercisers than low impact type activities.[1,2] However, it is not certain that the muscular requirements or mechanical dance maneuvers imposed by low impact activities are metabolically demanding enough to elicit an energy requirement appropriate or necessary for an exercise effect on multiple health outcomes,[3-5] effective weight loss and prevention of weight regain.[6,7]

It is important that exercise professionals and participants understand the physiological effects of a low impact Bodyattack™ session, and whether participants are experiencing similar benefits promoted for the high impact option. Lack of consistency with choreography, and other variables, such as the type of step, the level of impact of the step, arm movements and cadence of music, and intensity of the class limits the ability to use the results from past research on dance style aerobics and assume it valid for Bodyattack™.[8] On the other side, methods used to measure the physiological demands in past studies have been generally effective in generating results for the group exercise class but so far, they have not managed to break classes down to different segments and tracks for a more detailed analysis of the entire workout. Therefore, the aim of this study was to estimate the energy expenditure (EE) and intensity of a low impact Bodyattack™ session using combined heart rate (HR) and movement sensing technology.

## Methods

### *Participants*

Participants were 10 (8 males) normal-weight adults (body mass index=23.2 ± 2.8 kg.m$^{-2}$ | body fat = 14.6 ± 3.3%), aged 33 ± 3 years old. Participants were all Bodyattack™ instructors or weekly attendants of Bodyattack™ class for at least 6 months.

Exclusion criteria included: existence of any medical condition that limited physical activity; diet changes occurring within a few days before the session; to have eaten, smoked, drink coffee or alcohol within 12 hours before each session; have slept less than eight hours before the session; to have made a vigorous effort on the 24 hours previous to each session; to report the use of anabolic steroids or other growth factors; to be a high-competition athlete.

An informed consent was signed by all participants. This study was submitted to, and approved by, the Faculty Institutional Review Board for testing of human subjects (4/2012).

### *Experimental Design*

Maximal oxygen consumption (VO2max) was determined using an individualized protocol on a motorized treadmill to exhaustion. The protocol started with a 5-min warm-up, followed by 1 mph increments every 2 min for 4 min, after which 2.5% grade increments were added every minute until exhaustion. The speed of the treadmill in stage 1 was selected individually based on the participant's level of mobility and stride length. The protocol ended with a 1 min active recovery plus 2 min of passive recovery in the sitting position.

Inspired and expired gases were continuously analyzed, breath-by-breath, through a portable gas analyzer (K4b2, Cosmed, Rome, Italy). Before each test, the $O_2$ and $CO_2$ analyzer were calibrated using ambient air and standard calibration gases of known concentration (16.7% $O_2$ and 5.7% $CO_2$). HR was continuously monitored (Polar Electro Oy, Finland). VO2max was defined as the highest 20-second value attained in the last minute of effort provided 2 of the following criteria were met: (1) Attaining ~90% of predicted maximal HR (220-age); (2) Plateau in VO2 with an increase in workload (<2.0 mL.kg$^{-1}$.min$^{-1}$); (3) Rating of perceived exertion ≥ 18 for adults (6-20) and; (4) Respiratory exchange ratio ≥ 1.1 for adults; 5) subjective judgment by the observer that the participant could no longer continue, even after encouragement.

The right brachial systolic (SBP) and diastolic blood pressures (DBP) were measured following at least 5 minutes in the seated position using an automated oscillometric cuff (HEM-907-E, Omron, Tokyo, Japan).

Energy expenditure (EE) was measured during a Bodyattack™ session using a combined HR and motion sensor monitor (Actiheart, CamNtech Limited, Cambridge UK). The monitor was worn on a polar wearlink belt placed on the chest throughout the entire session. Initially, participants performed an 8-min step test at a step height of 21.5 cm, the stepping speed ramps linearly increased from 15-33 step cycles/min. Step test provided individual calibration of HR-PAI (Physical Activity Intensity). Subsequently, the device was initialized in the *long-term* option and started to record HR and acceleration with 15-sec epochs. Data from the monitors were downloaded to the commercial software (version 4.0.99). The CamNtech software algorithm allowed data cleaning, recovering and interpolation of missing and noisy HR. Physical Activity EE was estimated using the individual HR calibration model, with HR and accelerometry data, available in the commercial software (Actiheart software version 4.0.99, CamNtech Limited). Total EE was estimated by adding to the Physical activity EE, the thermic effect of food (~10%) and the resting EE, estimated using the Schofield equation,[9] as suggested by the commercial software.

The exercise session was a choreographed Bodyattack™ session (release 75th), with a duration of 60 minutes. The low impact option is characterized by the participant maintaining 1 foot in contact with the floor at all times, disallowing any movement that incorporates hopping or jumping. Bodyattack™ has a pre-established format in terms of structure, intensity and sequence of movements. It is built with 12 tracks with different goals and intensity levels, where track 1 (152 bpm) corresponds to the warm-up and track 12 (68 bpm) to stretching. Tracks 2 (160 bom), 3 (168 bpm), 4 (172 bpm), 8 (168 bpm) and 9 (172 bpm) correspond to aerobic work, with tracks 4 and 9 displaying intensity peaks. Tracks 5 (132 bpm), 10 (132 bpm) and 11 (132 bpm) focus on strength work and stabilization and allow the recovery of the cardiovascular parameters. Track 6 (168 bpm) corresponds to the upper body muscular recovery and to the gradual reactivation of the cardiovascular system, whereas track 7 (168 bpm) follows the same goal by developing agility.[10] Built upon an ecological approach, the same instructor conducted all sessions.

*Statistical Analysis*

Descriptive statistics, presented as mean and standard deviation, were used to characterize the sample. All variables were verified for normality using Shapiro-Wilk test. Comparisons of average HR from track to track were performed using repeated measures ANOVA. The data was analyzed using IBM SPSS Statistics for Windows, Version 20.0 (Armonk, NY: IBM Corp). For EE and HR comparison with those provided by the Program Manual,[10,11] a one sample t-test and a Chi-squared test were computed using *MedCalc Statistical Software* (*MedCalc software, mariakerke, belgium*). For all tests, statistical significance was set at $p<0.05$.

## Results

Table 1 presents the characterization of the hemodynamic and cardiorespiratory parameters at rest and at peak effort during the cardiorespiratory test.

**Table 1.** Characterization of the Hemodynamic and Cardiorespiratory parameters

| | Average ± SD | Min - Max |
|---|---|---|
| Resting SBP (mmHg) | 126.8 ± 9.2 | 110 – 145 |
| Resting DBP (mmHg) | 78.9 ± 8.6 | 70 – 95 |
| Resting HR (bpm) | 56.7 ± 6.8 | 49 – 73 |
| Maximal HR (bpm) | 172.8 ± 12.3 | 157 – 195 |
| $VO_2$ max (ml/kg/min) | 37.0 ± 3.7 | 32.3 – 41.8 |
| Respiratory exchange Ratio | 1.18 ± 0.06 | 1.1 – 1.3 |

SBP: systolic blood pressure; DBP: diastolic blood pressure; HR: heart rate; VO2 max: maximal O2 consumption; RER: respiratory exchange ratio.

Average duration of the Bodyattack™ session was 60 ± 2.8 minutes. Table 2 presents the physiological demands of the Bodyattack™ session with an average Total EE of 469.4 ± 170.8 kcal, corresponding to 7.8 ± 2.8 kcal/min.

**Table 2.** Characterization of the physiological demands of the Bodyattack™ Session

| | Average ± SD | Min - Max |
|---|---|---|
| Total EE (Kcal) | 469.4 ± 170.8 | 280 – 832 |
| Physical Activity EE (Kcal) | 350.5 ± 147.2 | 198 – 661 |
| Average HR (bpm) | 110.8 ± 23.6 | 80.8 – 142.9 |
| Maximal HR (%) | 63.8 ± 11 | 51.5 – 82.0 |
| HR Reserve (%) | 46.11 ± 15.49 | 28.11 – 72.68 |
| Time spent in Low Intensity (min) | 33.7 ± 23.6 | 4 – 61 |
| Time spent in Moderate Intensity (min) | 10.5 ± 9.6 | 0 – 29.75 |
| Time spent in Vigorous Intensity(min) | 16.7 ± 18.9 | 0 – 48.6 |

EE: energy expenditure; HR: heart rate.

The session was then analyzed per track of the Bodyattack™ routine and displayed in Figure 1A for HR response and Figure 1B for Activity EE. Track 1 elicited the lowest HR response compared to all other tracks (d= -38.18 to -21.86, $p<0.05$) except for track 12 ($p=0.10$). Physical Activity EE was also lowest in track 1 compared to all (d=-22.11 to -15.14 bpm, $p<0.05$) except track 11 ($p=0.307$) and 12 ($p=0.340$). The average HR response to track 9 was higher than in tracks 3 (d=7.34 bpm, $p=0.03$), 4 (6.25 bpm, $p=0.05$), 5 (d=6.90 bpm, $p=0.04$), 7 (d=6.87 bpm, $p=0.008$), 8 (d=3.64 bpm, $p=0.04$), 11 (d=19.67 bpm, $p=0.003$) and 12 (d=30.02 bpm, $p<0.001$). Similarly, the average Physical Activity EE to track 9 was higher than in tracks 5 (d=5.83 Kcal, $p<0.001$), 6 (d=6.29 Kcal, $p=0.04$), 7 (d=5.25 Kcal, $p=0.01$), 8 (d=2.88 Kcal, $p=0.05$), 11 (d=14.84 Kcal, $p=0.01$) and 12 (d=26.65 Kcal, $p<0.001$). The HR response to tracks 11, 2, 3 and 4 was similar ($p>0.05$).

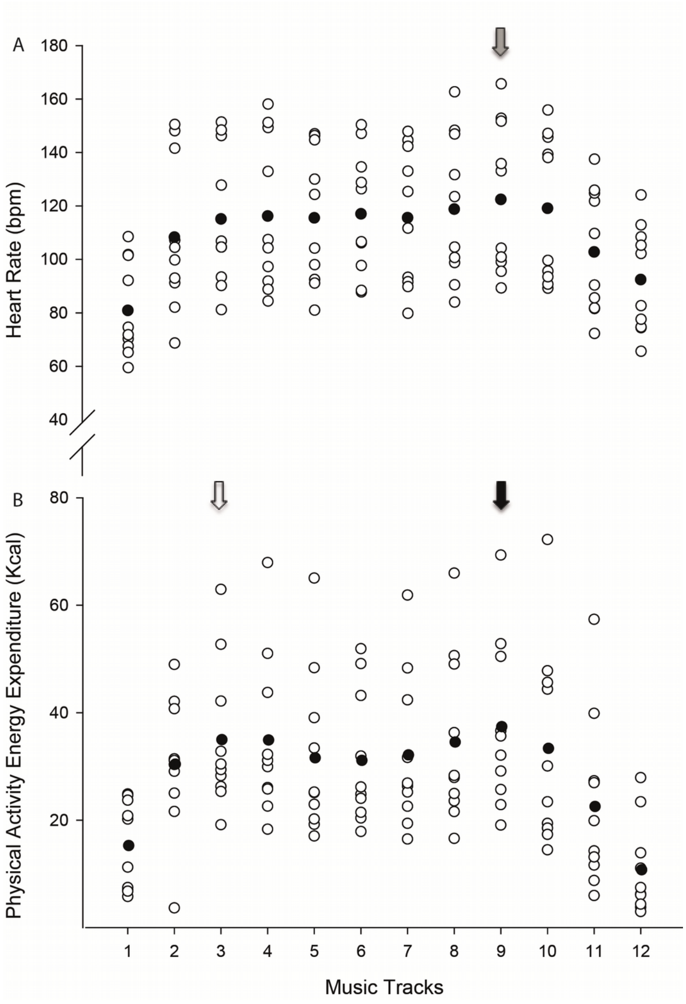


**Figure 1.** Individual (open) and average (black) Heart rate responses (A) and Activity Energy Expenditure (B) per music track during a Bodyattack™ session.

Arrows represent average intensity peaks: grey arrow: Significant different from tracks 3-5 7, 8, 11 and 12; white arrow: Significant different from track 5-7, 11 and 12; black arrow: Significant different from tracks 5-8, 11 and 12.

No significant differences were found in average HR ($p= 0.398$) or Physical Activity EE ($p=0.089$) between tracks of the aerobic (tracks: 2, 3, 4, 8 and 9) and strength components (tracks: 5, 10 and 11).

Average results of Total EE and HR obtained during the Bodyattack™ session with low-impact option were compared with values for a Bodyattack™ session with high-impact option as specified by *The Les Mills International Limited*.[10,11] Total EE was lower in the low impact option (-194.8 Kcal, p=0.006), but no significant differences were found in average % of age predicted maximal HR (-9.4%, p=0.707).

## Discussion

The present study is the first to show that the muscular requirements and dance maneuvers imposed by a low impact Bodyattack™ session are metabolically demanding to elicit an exercise effect on multiple health outcomes for most adults, if practiced beyond three days.week$^{-1}$.

Although it is common to recommend low-impact aerobics as an alternative to high-impact to prevent injury, it is important that EE meet accepted guidelines for increasing physical fitness levels.[3-6] Our results shown that a low impact Bodyattack™ session is metabolic demanding (total EE: 469.4 kcal | physical activity EE: 350.5 kcal), yields average intensities within the lower bound of the moderate range (64 to <77% maximal HR), and an amount of time in moderate to vigorous physical activity in line with recommendations for developing and maintaining cardiorespiratory fitness.[3,4] Although the Total EE is individual specific and not routine specific, three sessions per week of Bodyattack™ using the low impact options, may promote a weekly EE of 1408.2 kcal (physical activity EE: 1051.5 kcal). However, more physical activity may be necessary to attain weight loss and to prevent weight regain.[6] To this end, the metabolic demands of an high impact Bodyattack™ session may be necessary (11.1 kcal.min$^{-1}$ | 664.2 kcal.session$^{-1}$ | 1992.6 kcal.wk$^{-1}$).[11] As a general consideration for exercise prescription, beginners, less conditioned participants, or those with orthopedic restrictions should be advised to start with the low impact option and progress to the high impact option, confident that both options promote health benefits,[7,8,11-15] and are consistent with physical activity and exercise recommendations from sports medicine and exercise science organizations.[3,4]

The EE of other Les Mills Body Training Systems classes such as Bodycombat™, RPM™, Bodypump™ and Bodystep™ have been measured before.[11,16,17] Rixon et al.[16] estimated energy expenditure on 28 women participating in four different group exercise classes and the results compared to two running speeds. The study found that Bodypump™ expended the least amount of calories with 8.0 ± 1.6 kcal.min$^{-1}$, followed by Bodystep™ with 9.6 ± 1.0 kcal.min$^{-1}$, Bodycombat™ with 9.7 ± 2.0 kcal.min$^{-1}$, and RPM™ with 9.9 ± 1.9 kcal.min$^{-1}$.[16] A non-peer reviewed publication by Lythe and Pfitzinger[11,17] using a sample of 10-15 instructors and experienced participants, reported measured EE of 7.2 ± 1.6 kcal.min$^{-1}$, 10.2 ± 1.1 kcal.min$^{-1}$, 10.4 ± 1.8 kcal.min$^{-1}$, and 12.8 ± 1.9 kcal.min$^{-1}$, respectively. Methodological differences may explain the discrepancies between studies. The restrictive nature of testing to allow for gas analysis in Lythe and Pfitzinger's study[11,17] meant that movement needed to be restricted, which could have prevented subjects from completing the class at their normal intensity level. Rixon et al.[16] used HR and prediction equations as a mean to estimate EE, which can be inaccurate and has not been validated as a mean of measuring EE in aerobic dance. Keeping these limitations in mind, the metabolic demand of a Bodypump™ session and a low impact Bodyattack session™ (7.83 ± 2.9 kcal.min$^{-1}$) seem to be alike.

Greater clarity in interpreting aerobic dance EE can be derived by considering the dance exercise method. Low impact routines cost 3.8-4.93 kcal.min$^{-1}$, whereas the associated costs of high impact routines have been reported to range from 10.44-11.17 kcal.min$^{-1}$.[7] Yet, conflicting results have been reported in the literature concerning HR responses to aerobic dance exercise, likely due to the interaction between the effects of impact and arm movement. Darby et al.[18] assessed the physiological responses to aerobic dance exercise with variations of impact, step, arm movement and cadence. The authors found that the low impact-more arm movement condition was greater than all other conditions for HR (86.8% maximal HR). In contrast, Williford et al.[19] reported that the high impact-low intensity aerobic dance routine elicited the same mean relative HR response than the low impact- high intensity aerobic dance routines (83% maximum HR reserve). Likewise, we found no significant differences in average HR of a low impact Bodyattack™ session (63.8 ± 11% maximal HR) and the HR response to a high impact Bodyattack™ session as reported by Lythe and Pfitzinger (73.2 ± 9.7% maximal HR).[11] Still, the relative metabolic load was significantly greater for the high impact routines.[18,19] These differences in energy requirement, despite comparable HR responses, may be due to less incorporation of large muscle mass (leg impact) activity, characteristic of high impact dance, in favor of vigorous arm movements typically employed in low impact aerobic dance.

Bodyattack™ routines performed at a low impact option may be sufficient to meet minimal recommendations for developing and maintaining cardiorespiratory fitness, if practiced beyond three days.week$^{-1}$. Although appropriate for untrained individuals and those with orthopedic limitations, energy requirements of low impact Bodyattack™ may not be enough to elicit an effective weight loss.

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