



The Energy Expenditure of Tinikling: A Culturally Relevant Filipino Dance

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ABSTRACT

International Journal of Exercise Science 12(4): 111-121, 2019. Filipino Americans have higher risks for developing cardiovascular disease than many other U.S. minority groups and Caucasians. As a precursor to developing a culturally-relevant physical activity (PA) intervention targeting high-risk Filipino Americans, this study sought to evaluate the energy cost and intensity of Tinikling, or bamboo dance, a popular type of Philippine folk dance. These energy cost values were directly compared to the moderate-to-vigorous PA (MVPA) cut-points commonly used to define the PA guidelines. Twenty-two pairs of Filipino American adults performed five minutes of continuous Tinikling dance to a three-count rhythm and standardized music. Each dancer wore a portable metabolic system to directly assess the oxygen uptake from the last two minutes of dancing. These metabolic data were then transformed to units of metabolic equivalents (METs). Mean METs for all dancers (Mean \pm SD; 6.9 ± 1.4 METs; $P < 0.001$), as well as for women (6.9 ± 1.3 METs; $P < 0.001$) and men analyzed separately (7.0 ± 1.0 METs; $P < 0.001$), were significantly higher than both 3.0 and 6.0 MET MVPA cut-points. These results support the use of Tinikling dance with Filipino American adults as a PA intervention tool in future studies, as well as a means to satisfy the guidelines for prescribed weekly PA.

KEY WORDS: Activity energy expenditure, Filipino American, Metabolic equivalent, Physical activity

INTRODUCTION

According to the Racial and Ethnic Approaches to Community Health (REACH) Risk Factor Survey, members of ethnic and racial minority populations in the United States (U.S.) continue to experience significant health disparities relative to comparable non-minority U.S. communities (21). For example, higher rates of hypertension (HTN), type 2 diabetes mellitus (T2DM), obesity, smoking, and other cardiovascular diseases, as well as lower rates of meeting the federal physical activity standard were self-reported by adults who self-identified as African American, Hispanic, Asian or Pacific Islander, and American Indian. Given that adequate physical activity (PA) is known to ameliorate the rates for many chronic diseases, as well as the magnitude of many cardiometabolic risk factors (28), some health professionals have advocated the development of culturally-based PA and rehabilitation programs when working with

minority populations (22, 26). The success of such programs, however, are highly dependent upon accurate dose-response determinations between PA intensity and cardiometabolic responses that are specific to the PA. Indeed, many such dose-response relationships are well-known for traditional forms of PA (e.g., walking, jogging, use of stationary exercise equipment, etc.) and even well-documented as a MET-based compilation for many activities (1), but the same information for culturally-specific activities is much less exhaustive. Thus, a common precursor to implementing newly developed culturally-based PA programs is the need to document the cardiometabolic responses.

While the number of U.S. minorities have steadily increased for decades, the rate of growth for Asian Americans was faster between 2000 and 2010 than any other minority group (18). At about 5% of the total U.S. population in 2010, Asian Americans live mostly on the west coast of the continental U.S. and primarily identify as having Chinese, Filipino, or Asian Indian ancestry. As the second largest subgroup of Asian Americans, Filipino Americans are the largest group of Asian Americans in 10 of the 13 western U.S. states with Chinese Americans dominating the other three (18). Filipino Americans have also been found to have a disproportionately high risk for HTN, T2DM, metabolic syndrome, as well as higher visceral adipose tissue when compared with other minority populations and Caucasians (2-5).

Clearly, the long-term health of many Filipino Americans could benefit from satisfying the 2008 U.S. federal PA guidelines – i.e., Accumulating at least 150 minutes of moderate intensity (≥ 3.0 METs) weekly PA (28). Based on the United States Department of Health and Human Services, effective health interventions must be consistent with the shared beliefs, values, and practices of the target population. Activities that are culturally relevant help motivate minority populations to engage in regular PA. Interestingly, several studies have found dancing to be a common self-reported moderate-to-vigorous PA in Filipino Americans (6, 27). A traditional form of Philippine folk dance called Tinikling, or bamboo dance, is commonly practiced in areas of the U.S. with strong Filipino communities (13). Tinikling commonly involves two people moving two bamboo poles back and forth along the ground, with the poles tapping against each other and the ground to emphasize a musical rhythm, while simultaneously one or more dancers are stepping over and between the poles (13). This type of dance has also been the focus for Filipino cultural awareness groups, such as the Kalahi Philippine Folkloric Ensemble in Las Vegas, NV, who use traditional dance as a means to promote traditional Filipino culture in the U.S. Given the popularity of traditional Filipino folk dances in many Filipino American communities, Tinikling could be used as the foundation for creating a culturally-based PA program to help address Filipino Americans' high prevalence of cardiovascular risk factors (25). However, there does not appear to be any published information about the cardiometabolic influences of Tinikling, or any other Filipino style of folk dance, in the research literature or elsewhere.

Given the continued need for creative and culturally-relevant PA intervention strategies, especially those focused on minority populations in the U.S., the current study sought to better understand the cardiometabolic influences of Tinikling dance as a form of PA. As such, *the objective* of this study was to characterize the energy cost and intensity of Tinikling dance for

experienced adult dancers. In doing so, the metabolic intensity of Tinikling dance was compared directly to the 3.0 and 6.0 MET thresholds for moderate and vigorous intensities, respectively, that are used by the U.S. federal PA guidelines to promote and maintain health (14, 28).

METHODS

Participants

Volunteers from the surrounding community gave written informed consent in accordance with procedures approved by the Internal Review Board (IRB) of Montana State University (MSU). Testing for participants, hereafter referred to as dancers, occurred during a single 60-minute visit to the Exercise Physiology Laboratory (constant 22-23° C; 35-40% relative humidity; 672 m altitude) on the University of Las Vegas (Las Vegas, NV) campus. To qualify for this study, dancers had to pass a Physical Activity Readiness Questionnaire (PARQ) and self-report having at least a recreational familiarity with Tinikling dance to a three-count rhythm.

Tinikling Dance: Tinikling is often described as a folk dance that represents the attempts of Filipino rice farmers to catch and prevent the Tikling bird from stealing ripe rice grains from the fields (9). The farmers are represented by two people using two long bamboo poles to tap on the floor and clap against each other in a manner that is rhythmically timed to music. The Tikling birds, in turn, are represented by the dancers who may use a combination of leaping, hopping, and skipping to avoid the clapping of bamboo poles on their ankles (i.e., avoiding the rice field traps that were set by the farmers). Use of the upper limbs by the dancers extends the symbolism with arm and hand movements tending to lyrically flow left-to-right and back again in time with the music and the hopping. However, like all forms of dance, this description of Tinikling should serve as a starting point rather than an endpoint to understanding common variations of the dance which can include the hands fixed on the hips or unmoving at the dancers' sides, as well as highly athletic leaping moves designed to impress onlookers. A good description of traditional Tinikling dance is provided by Buot (9).

Protocol

Prior to their lab visits, dancers were instructed to wear appropriate clothing and footwear for exercise, to be rested and ready for exercise, and to avoid caffeinated food and beverages at least 2-3 hours prior to testing. Since Tinikling dance is commonly performed in small groups, two dancers were tested simultaneously using two identical sets of testing equipment. After measuring body height and weight to the nearest 0.1 cm and kg (Health-o-Meter beam scale, Continental Scale Corp., Bridgeview, IL, USA), respectively, the dancers were each fit with a small backpack that carried a portable metabolic measurement system.

After both dancers had been readied with the measurement equipment, the dancers were instructed to sit quietly for 5 minutes for the measurement of sitting resting metabolic rate (SRMR). Next, the dancers were given a 4-minute semi-structured warmup that included 2-3 minutes of treadmill walking (self-selected speed and 0% grade) and some light intensity range of motion exercises. During this warmup, the dance music was cued to start and two investigators readied themselves to move the nine-foot (2.9 m), two-inch (5.1 cm) diameter

bamboo poles for the dancers. The investigators sat on the floor on their knees holding the end of the poles and performed the three-count rhythm. After the warmup, the music was started and the investigators began tapping the two poles to the ground. On counts 1 and 2, they tapped the poles on the ground, on count 3 they glided the poles together. The prompt was 1, 2, 3 – tap, tap, close, then repeated, with each audible prompt occurring at a 1 Hz frequency. Once the rhythm was established, the dancers began dancing (hopped on their right foot in between the poles on count 1, then switched to their left foot on count 2, and landed outside of the poles on count 3) at an intensity that could be maintained for 5 consecutive minutes. While the music and rhythm were kept constant between dance pairs, each dancer chose their preferred dance choreography (e.g., style of hand and arm movements) such that exercise intensity could be maintained at a steady intensity for 5 minutes. The stylistic differences in dance between individual dancers was not documented.

After 5 minutes of dancing, the music was stopped and the dance pair was allowed to stand or walk around the lab to actively recover for 3 minutes, which was then followed by another 5 minutes of quiet sitting rest. Once this last resting phase was completed, the measurement equipment was removed from both dancers.

Energy expenditure was determined using standard open-circuit indirect calorimetry procedures. Both oxygen uptake (VO_2) and carbon dioxide production (VCO_2) were assessed during all activities using a portable metabolic measurement system (Oxycon® Mobile; VIASYS, San Diego, CA USA) that was worn on a small backpack during all activities. This metabolic system has demonstrated similar validity as other portable metabolic measurement systems in both lab and field settings (13, 24). Just prior to each test, the metabolic system's oxygen and carbon dioxide analyzers were calibrated using certified gases of known concentration, and the system's pneumotach for ventilation measurement was calibrated using an automated routine that included both low and high flowrate measurements. Within 10 minutes of completing the calibration, the metabolic system was attached to the dancer using a face mask affixed with an adjustable fabric headpiece. Metabolic measures were recorded continuously across all activities without recalibration. While data sampling for the metabolic system was breath-by-breath, these data were summarized after testing at one-minute sample intervals for subsequent analyses. The mass of all the measurement equipment (M_E , kg; metabolic system, the backpack, the heart rate chest strap) carried by each dancer totaled 1.50 kg, and data sampling for the metabolic systems were synchronized relative to an external timer.

Data Transformations: The energy cost of Tinikling dance was characterized as both an exercise intensity in units of both METs and Activity Energy Expenditure (AEE), where AEE was defined as the relative energy cost of exercise above resting metabolic rate. To characterize the *relative rate of energy expenditure*, the last 2 minutes of the metabolic data, including VO_2 and HR, for each dance bout were averaged with VO_2 being converted to both relative VO_2 (ml/kg/min) and MET units (relative $\text{VO}_2 / 3.5$) using each dancer's total mass, M_T (kg). Total mass was calculated as the sum of each dancer's body mass (M_B , kg) and the equipment mass (M_E , kg). Next, the relative caloric rate of energy expenditure (kcal/kg/min) for both SRMR and dance were calculated using Weir's equation (29): $\text{Relative EE} = (3.9 \times \text{VO}_2 + 1.1 \times \text{VCO}_2) / M$, where

VO_2 (L/min) and VCO_2 (L/min) were the 2-minute averages for each dancer and M was either M_B for SRMR and M_T for dancing. Finally, activity energy expenditure (AEE, kcals/kg/min) was calculated as the relative EE for dance above that for SRMR: $AEE = (EE_{Dance} - EE_{SRMR})$.

Statistical Analysis

Intraclass reliability (ICC) for internal consistency was computed between the last two minutes of VO_2 , CO_2 , HR, METs, EE, and AEE (8). Next, the transformed metabolic (relative VO_2 , METs, EE, AEE) and were summarized (Mean \pm SD) for descriptive purposes. Mean cardiometabolic values (HR, HR%, METs, AEE) were also statistically compared between women and men using two-sample t-tests at the 0.05 alpha level. The HR% for each dancer was computed as the mean HR during dance as a percentage of age-predicted maximal HR ($APMHR = 220 - Age$), where $HR\% = (HR / APMHR) \times 100$.

To satisfy the study objective, the mean MET value for Tinikling dance was statistically compared to the 3.0 and 6.0 MET threshold cut-points (CP) for moderate and vigorous intensity physical activities (14), respectively, using two-sided T-tests at the 0.05 alpha level. The effect sizes (ES) for these comparisons were also calculated using Cohen's d (10): $d = * EE_{METs} - CP * / SD_{METs}$, where EE_{METs} and SD_{METs} were the sample mean and SD determined for Tinikling dance and CP was values of either 3 or 6 to correspond with the moderate and vigorous intensity CPs, respectively. Note that the common practice guidelines for interpreting the magnitude of ES were used for this study - i.e., $0.2 \leq$ "small" $ES < 0.5$, $0.5 \leq$ "medium" $ES < 0.8$, and "large" $ES \geq 0.8$. As such, for an alpha of 0.05 and a two-tailed t-test, a sample size of at least 20 would be needed to detect a "small" effect size at a power of at least 80% (9). Lastly, simple linear regression procedures were used to determine the strength of the linear relationship between AEE and METs using common summary statistics (R^2 , SEE). All statistical evaluations were performed using Statistix 10 software (Analytical Software, Tallahassee, FL USA).

RESULTS

A total of 11 dance pairs (15 women and 7 men), all of whom self-identified as being Filipino American, were tested with all data collected successfully. A summary of the dancers' demographics is provided in Table 1. According to BMI classification standards for adults (7), the women dancers were represented within all BMI categories from underweight to obese while the men were classified within normal weight, overweight, and obese categories (Table 1).

Intraclass Reliability: There were no significant differences between the last 2 minutes of dance data for any of the metabolic variables ($P = 0.39 - 0.58$). In addition, the ICC calculations were consistently moderate in magnitude with values between 0.62 and 0.66 for all metabolic variables. Given the lack of significant differences and moderate ICC values, the average of the last two minutes were used for all subsequent analyses.

Cardiometabolic Responses: A summary of the metabolic variables is provided in Table 2. Mean METs for all dancers ($P < 0.001$; $ES = 2.8$), as well as for women ($P < 0.001$; $ES = 3.0$) and men (P

< 0.001; ES = 4.0) analyzed separately, were all significantly greater than the 3.0 MET moderate intensity cut-point.

Table 1: Summary demographics for study participants. BMI classifications are number of observations, where all other values are expressed as Mean (SD).

Sex	Statistics	Age (yrs)	Height (cms)	Mass (kg)	BMI (kg/m ²)	BMI Classifications			
						<u>UW</u>	<u>NW</u>	<u>OW</u>	<u>OB</u>
Women [n=15]	Mean (SD)	32 (10)	157.5 (6.4)	61.5 (11.0)	24.8 (4.5)	2	7	3	3
Men [n=7]	Mean (SD)	38 (12)	169.8 (11.6)	76.9 (6.7)	27.0 (4.9)	0	3	3	1

Notes: Body Mass Index (BMI) classifications are as follows: Underweight (UW) is BMI < 20.0; Normal Weight (NW) is 20 ≥ BMI < 25.0; Overweight (OW) is 25.0 ≥ BMI < 30.0; Obese (OB) BMI ≥ 30.0.

In fact, these mean MET values were also significantly higher than the 6.0 MET vigorous intensity cut-point for women (P = 0.031; ES = 0.7), men (P = 0.040; ES = 1.0), and all dancers (P = 0.003; ES = 0.6). These results are explained by the fact that 17 of the dancers’ MET values exceeded the 6.0 MET cut-point while the other 5 values were between 3.0 and 6.0 METs. Complimenting these observations is the fact that the computed ES values were all “medium” (0.50-0.79) to “large” (≥0.80) indicating that the magnitude of the observed differences were physiologically meaningful. Finally, the average values of exercise HR, HR%, METs, and AEE were all statistically similar (P = 0.86, 0.85, 0.56, 0.93, respectively) between the women and men which indicates that their physiological responses were statistically similar.

Table 2: Summary of metabolic data for dance study participants which included 15 women and 7 men (n=22 total). Except for sitting RMR, all variables are averages from the last two minutes of a 5-minute bout of continuous dancing. All values expressed as Mean (SD) [Range].

Group	Sitting RMR (ml/kg/min)	Heart Rate (BPM)	Relative VO ₂ (ml/kg/min)	METs	AEE (kcal/kg/min)
Women	3.48 (0.70)	170 (19) [141-198]	24.1 (4.6) [15.8-31.1]	*6.9 (1.3) [4.5-9.0]	0.1083 (0.0217) [0.0641-0.1473]
Men	4.30 (1.40)	168 (19) [148-201]	24.1 (3.5) [19.2-29.4]	*7.0 (1.0) [5.5-8.4]	0.1064 (0.0161) [0.0833-0.1322]
All Dancers	3.74 (1.40)	169 (19) [141-201]	24.2 (4.9) [15.8-31.1]	*6.9 (1.4) [4.5-9.0]	0.1077 (0.0243) [0.0641-0.1473]

* Indicates mean MET values that were significantly greater than a value of 6.0 METs.

Notes: RMR = Resting metabolic rate; BPM = beats/min; VO₂ = oxygen consumption; METs = metabolic equivalents; AEE = activity energy expenditure.

The correlational relationship between computed values of AEE and METs are shown in Figure 1 ($R = 0.98$; $P < 0.001$). Using the best-fit regression line shown in Figure 1 to predict AEE from METs, the 3.0 and 6.0 MET cut-points for moderate and vigorous activity correspond to values of 0.0421 and 0.0925 kcals/kg/min, respectively.

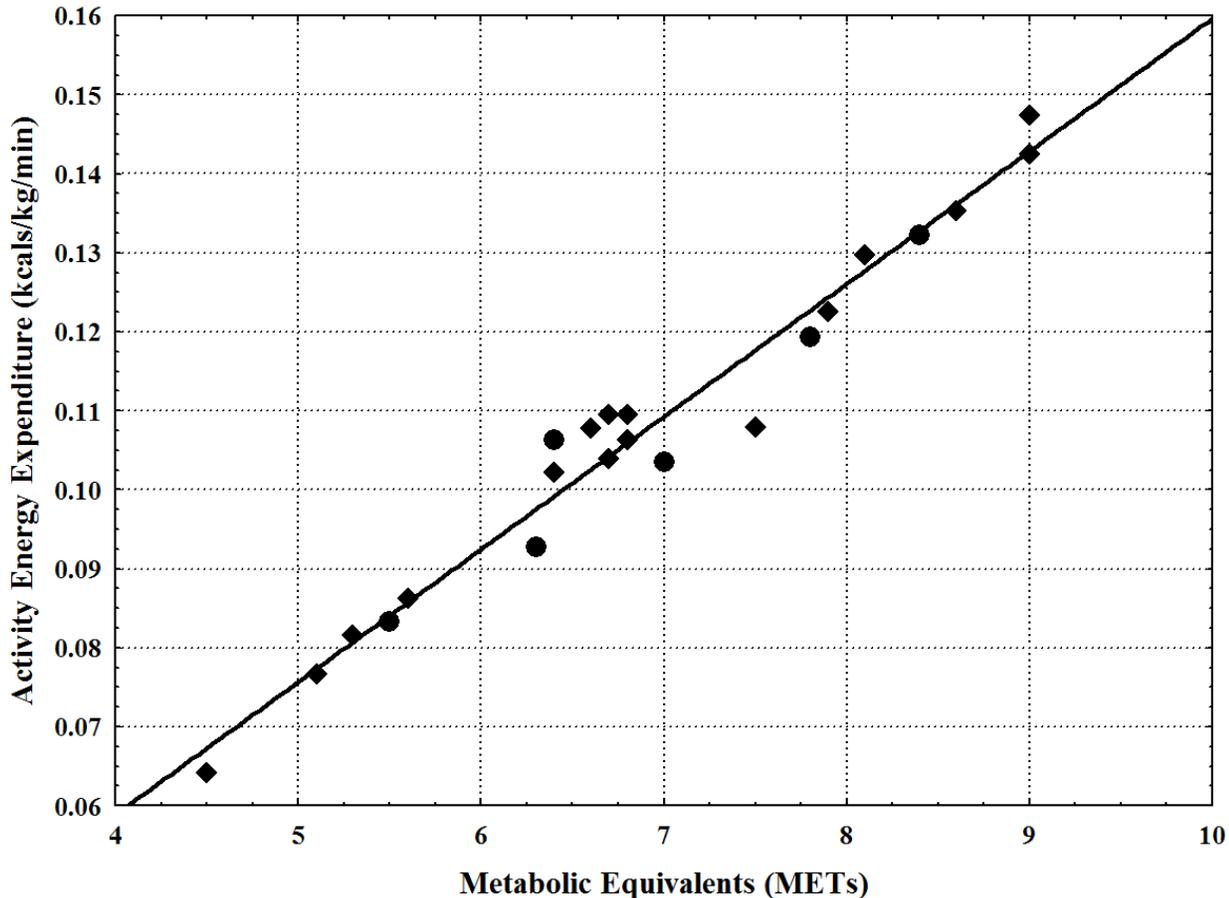


Figure 1. Scatterplot and simple linear regression between AEE and METs for Tinikling dance. The model for the best-fit regression line (shown) for 15 women (solid diamonds) and 7 men (solid circles) was as follows: $AEE = 0.0168 \times METs - 0.0083$ ($R^2 = 0.97$, $SEE = \pm 0.00002$ kcals/kg/min; $P < 0.001$).

DISCUSSION

The primary objective of this study was to characterize the energy cost of Tinikling, a traditional Philippine folk dance commonly practiced as a form of recreational PA by Filipino Americans. When compared to the threshold intensities used by the PA standards (28), the mean MET intensity of 6.9 METs for Tinikling dance (Table 2) easily exceeded both the 3.0 MET and the 6.0 MET intensity thresholds. The same result was found when the MET data were analyzed by sex, with women (Mean \pm SE: 6.9 \pm 0.4 METs) and men (7.0 \pm 0.4) having nearly identical relative metabolic responses. In fact, the entire cluster of cardiometabolic responses of METs, AEE, HR, and HR% were all statistically similar between women and men (Table 2). Thus, Tinikling dance in this population of healthy Filipino American adults can easily be classified as a moderate-to-

vigorous PA for both women and men. Further, these results are consistent with other *direct assessments* of MET intensities for several forms of dance. Usagawa et al (26), for example, reported mean MET values of 5.7 and 7.6 for low and high intensity hula dancing, whereas Lankford et al (19) reported a broader MET intensity range for several styles of ballroom dancing which included the Waltz (5.3 METs), Foxtrot (5.3 METs), Cha-Cha (6.4 METs), and Swing (8.1 METs).

Instead of *direct assessment* of MET intensity for dancing, several studies have used *indirect techniques* that involve predicting MET intensity with one or more predictor variables using a prediction equation or algorithm. Regardless, use of these indirect techniques to predict the MET intensity for many forms of dancing often exceed the 3.0 and 6.0 MET intensity thresholds that define MVPA activity. For example, using a heart rate calibration curve derived from a stepping test, Emerenziani et al (12) reported intensities of 3.9-5.5 METs for different types of Salsa dancing. Similarly, Massidda et al (23) used a multichannel arm monitoring device with couples competing in an international Latin dance competition and reported mean intensity values of 4.9 to 7.0 METs for five types of dance (Cha cha, Samba, Rumba, Paso doble, Jive). When these results are combined with those from the present study, it seems clear that many forms of dance, including Tinikling, can easily induce a cardiometabolic response that exceeds the 3.0 MET intensity threshold of the PA guidelines (28).

The data plotted in Figure 1 show that there is a tight correlational relationship between units of AEE and METs for Tinikling dance. A strong relationship is expected since AEE is simply an alternative unit of energy expenditure without the influence of individual differences in RMR. Given that units of AEE are now commonly used like METs as a descriptive marker of activity intensity (16, 17), it seemed important to present the Tinikling dance data in both unit formats. As such, the interpretation of the AEE or MET data in Figure 1 are essentially identical - i.e., All mean energy expenditure values for Tinikling exceeded a moderate intensity (AEE ≥ 0.0310 ; METs ≥ 3.0), while most energy expenditure values also exceeded a vigorous intensity (AEE ≥ 0.0832 ; METs ≥ 6.0).

While the current descriptive study results are delimited to the population studied (i.e., adult Filipino Americans with a broad range of fitness levels and Tinikling dance experience) and the measurement methodology (i.e., dancing for 5 mins continuously at 1 Hz tapping frequency while wearing a portable metabolic measurement system), the results generally support further study of Tinikling dance as a means for improving cardiovascular fitness and improving cardiometabolic risk factors. Regardless, there are several study limitations that should be highlighted. First, there should have been better documentation of the participants' level of familiarity with Tinikling dance, as well as the settings in which this dance had been performed by our dancers (e.g., physical education class in school, community activities, family gatherings). This information would have helped to more accurately anchor the MET values reported in Table 2 to specific levels of dance experience. Second, while the music and tempo of dancing were standardized for this study, the dance choreography itself was not highly standardized between individuals. Factors such as the vertical height of hopping and the degree of knee lifting (hip flexion), as well as the style of degree of hand and arm movements, most certainly caused

interindividual variation in observed MET values. Another unknown factor is how the observed MET values related to each dancer's cardiorespiratory fitness as measured with maximal oxygen uptake (VO_{2MAX}). We can speculate, for example, that those dancers with higher VO_{2MAX} values may have been more likely to have higher MET values, as well as more capacity to add hand and arm movements, as well as more dynamic hopping movements.

In conclusion, this is the first study to evaluate the cardiometabolic demands of Philippine Tinikling dance using healthy adults who were familiar with this style of dance. Specifically, we found that the mean metabolic intensity of Tinikling dance (6.9 METs) easily exceeded both the 3.0 and 6.0 intensity threshold commonly used to define moderate (3.0 to 5.9 METs) and vigorous (6.0+ METs) intensity activities. While the this study was descriptive in nature, the results support further exploration of Tinikling dance as a tool for use in developing a culturally-specific PA program focused on high risk Filipino Americans. Thus, the use of Tinikling dance as a culturally-specific activity may be an effective means for targeting Filipino American adults who are sedentary and at risk for cardiovascular disease.

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