Quantifying the benefits of inefficient walking: Monty Python inspired laboratory based experimental study

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ABSTRACT

OBJECTIVE

To compare the rate of energy expenditure of low efficiency walking with high efficiency walking.

DESIGN

Laboratory based experimental study.

SETTING

United States.

PARTICIPANTS

13 healthy adults (six women, seven men) with no known gait disorder, mean (±standard deviation) age 34.2±16.1 years, height 174.2±12.6 cm, weight 78.2±22.5 kg, and body mass index 25.6±6.0.

INTERVENTION

Participants performed three, five minute walking trials around an indoor 30 m course. The first trial consisted of walking at a freely chosen walking speed in the participant's usual style. The next two trials consisted of low efficiency walks in which participants were asked to duplicate the walks of Mr Teabag and Mr Putey (acted by John Cleese and Michael Palin, respectively) in the legendary Monty Python Ministry of Silly Walks (MoSW) skit that first aired in 1970. Distance covered during the five minute walks was used to calculate average speed. Ventilation and gas exchange were collected throughout to determine oxygen uptake ($\dot{V}O_2$; mL O_2/kg/min) and energy expenditure (EE; kcal/kg/min; 1 kcal=4.18 kJ), reported as mean±standard deviation.

MAIN OUTCOME MEASURES

$\dot{V}O_2$ and EE.

RESULTS

$\dot{V}O_2$ and EE were about 2.5 times higher (P<0.001) during the Teabag walk compared with participants' usual walk (27.9±4.8 *v* 11.3±1.9 mL O_2/kg/min; 0.14±0.03 *v* 0.06±0.01 kcal/kg/min), but were not different during the Putey walk (12.3±1.8 mL/kg/min; 0.06±0.01 kcal/kg/min). Each minute of Teabag walking increased EE over participants' usual walking by an average of 8.0 kcal (range 5.5-12.0) in men and by 5.2 kcal (range 3.9-6.2) in women, and qualified as vigorous intensity physical activity (>6 resting metabolic equivalents).

CONCLUSIONS

For adults with no known gait disorder who average approximately 5000 steps/day, exchanging about 22%-34% of their daily steps with higher energy, low efficiency walking in Teabag style—requiring around 12-19 min—could increase daily EE by 100 kcal. Adults could achieve 75 minutes of vigorous intensity physical activity per week by walking inefficiently for about 11 min/day. Had an initiative to promote inefficient movement been adopted in the early 1970s, we might now be living among a healthier society. Efforts to promote higher energy—and perhaps more joyful—walking should ensure inclusivity and inefficiency for all.

WHAT IS ALREADY KNOWN ON THIS TOPIC

Inactivity levels globally have been largely intractable to campaigns to increase physical activity and boost cardiovascular fitness in adults

The inefficient walking techniques of Mr Teabag and Mr Putey in the 1970 Ministry of Silly Walks skit have been shown to be around three to seven times more variable than usual walking, but their energy inefficiency has not been quantified

WHAT THIS STUDY ADDS

Inefficient walking—Teabag style—increases energy expenditure in adults by about 2.5 fold compared with their usual walking style

Adults could achieve 75 minutes of vigorous intensity physical activity per week by walking in Teabag style—rather than their usual style—for about 11 min/day

Substituting usual style steps with Teabag style steps for about 12-19 min/day would increase daily energy expenditure by approximately 100 kcal

Introduction

Global rates of physical inactivity (defined by the World Health Organization as engaging in less than 150 minutes of moderate intensity activity per week, or equivalent)[1] have not budged in the past 20 years,[2] while the prevalence of cardiovascular disease has doubled since 1990.[3] In roughly the same time period, numerous structural factors alongside inactivity have caused the prevalence of obesity to triple in Europe and the United States.[4-6] Transportation infrastructure and urban planning, unsafe or inaccessible public spaces for recreation, and restrictive social norms are important barriers to physical activity. However, there is also a Darwinian neuro-physiology and psychology that selects or modifies individual behaviors to minimize perceived effort, termed TEMPA—theory of effort minimization in physical activity.[7]

To counter this problem, we propose PEMPA—practice of effort maximization in physical activity. We take our lead from the so far unrecognized scientific genius of Monty Python's Ministry of Silly Walks (MoSW; https://www.youtube.com/watch?v=TNeeovY4qNU), in which Mr Teabag considers a proposal to fund the promotion of Mr Putey's inefficient walking technique alongside other inefficient styles of walking. Had the health profession taken MoSW to heart in the 1970s, hearts everywhere might be healthier.

In proposing PEMPA, we recognize that evolution has adapted humans anatomically, biomechanically,[8 9] and physiologically[7 10 11] to move in increasingly energy efficient ways. Still, with respect to cardiovascular fitness, inefficiency of movement might be a desired trait.

The inefficient walking techniques of Teabag and Putey have actually been analyzed biomechanically before. On the basis of gait variability scores, Teabag's walk was judged to be up to 6.7 times more variable than typical walking, while that of Putey's was only 3.3 times more variable.[12] Unfortunately, energy expenditure was not measured in that study. In fact, we are not aware of a single study that has quantified the energy cost of walking like Teabag or Putey in the 51 years since the MoSW skit first aired. Given its potential to contribute to PEMPA, the purpose of this study was to fill this vital research gap.

Methods

Participants

Thirteen healthy adults (six women, seven men) between the ages of 22 and 71 participated in this study, which was approved by the Arizona State University institutional review board and conformed to the ethical standards of the Declaration of Helsinki. Participants were all non-smokers, had no personal history of gait disorder, cardiometabolic or pulmonary diseases, and did not have any orthopedic limitations that would prevent them from performing the walking trials in this study. After being informed of the nature of the study, including risks and benefits, all participants provided written consent.

Experimental procedures

Each participant performed all walking trials during a single visit to the exercise physiology laboratory. Upon arrival to the laboratory, body weight was measured on a Detecto beam scale (Webb City, Missouri, USA) and standing height was measured against a wall mounted stadiometer (Seca, Hamburg, Germany). Each participant was shown a video of the MoSW skit and was instructed to recreate the walks performed by the two main characters, Teabag and Putey, as accurately as possible.

Participants were then fitted with a lightweight, portable metabolic measurement system (Carefusion, San Diego, California, USA) that has been validated against the Douglas bag method.[13] Each participant stood still for five minutes while standing metabolic rate was measured. Participants then performed three, five minute walking trials around an indoor 30 m course. For the first trial, participants were asked to walk in their usual style at a normal pace. For the second trial, participants performed the Putey walk. For the third trial, participants performed the Teabag walk, including the major elements of the walk displayed outdoors (while walking to work) and indoors (mainly in his office at the MoSW).

The distance covered during each trial was recorded and the average walking speed was calculated for each walk. Ventilation and gas exchange were recorded throughout each trial for determination of oxygen uptake ($\dot{V}O_2$; mL O_2/kg/min) and carbon dioxide production ($\dot{V}CO_2$; mL CO_2/kg/min), which were used to determine the respiratory quotient ($\dot{V}CO_2/\dot{V}O_2$). The kcal (1 kcal=4.18 kJ) per liter O_2 value for each respiratory quotient[14] was used to convert $\dot{V}O_2$ to energy expenditure (EE; kcal/kg/min) as described previously.[15] After each of the first two walking trials, participants stood quietly while $\dot{V}O_2$ was monitored to ensure that it returned to their baseline standing metabolic rate before starting the next walking trial. This took less than five minutes. No adverse events occurred during any of the experimental procedures.

Statistical analysis

Linear mixed models were used to examine variances in $\dot{V}O_2$ and EE among participants across the different walking styles. Alpha was adjusted using the Bonferroni correction for multiple comparisons. All pairwise comparisons are reported as mean±standard deviation, and with 95% confidence intervals. Pearson correlations were performed to examine the relation between body mass and EE expressed in kcal/min during each of the three different walks.

Patient and public involvement

Neither patients nor the public were involved in conception, design, or execution of this laboratory based experimental study. As for MoSW, funding for Putey and Teabag walks remains problematic precluding public or patient participation at this time.

Results

Table 1 presents participant characteristics. Only the Teabag walk resulted in a significantly increased $\dot{V}O_2$ (27.9±4.8 mL/kg/min, 95% confidence interval 24.3 to

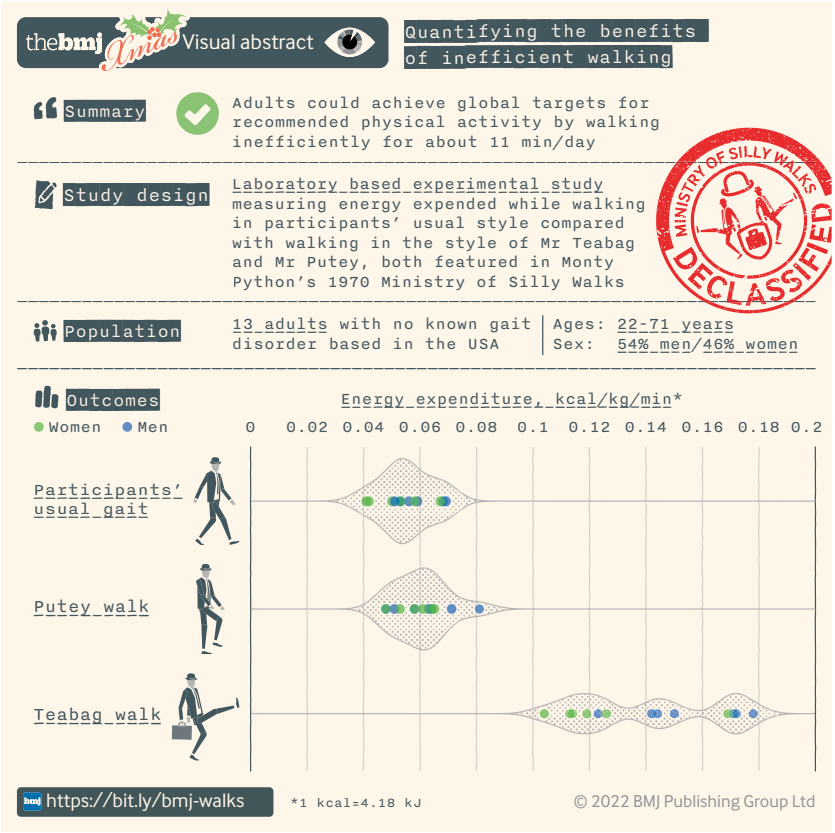

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Table 1 | Participant characteristics

Characteristic	Men (n=7)	Women (n=6)	All (n=13)
Age (years)	34.3 (16.6); 29 (24-33)	34.2 (17.2); 28 (24-35)	34.2 (16.1); 29 (24-34)
Height (cm)	181.4 (11.1); 180.3 (172.7-193.0)	165.8 (8.6); 170.3 (157.5-172.0)	174.2 (12.6); 172.5 (166.4-184.2)
Weight (kg)	83.5 (21.0); 77.2 (68.5-86.3)	72.1 (24.5); 63.2 (59.1-67.6)	78.2 (22.5); 68.5 (62.5-86.0)
Body mass index	25.1 (4.3); 24.4 (21.8-26.3)	26.2 (7.9); 23.6 (22.7-25.0)	25.6 (6.0); 24.3 (22.3-25.7)

Data are mean (standard deviation); median (interquartile range).

30.9) and EE (0.14±0.03 kcal/kg/min, 95% confidence interval 0.13 to 0.15; P<0.001) compared with the participants' usual walk ($\dot{V}O_2$: 11.3±1.9 mL/kg/min, 95% confidence interval 10.1 to 12.4; EE: 0.06±0.01 kcal/kg/min, 95% confidence interval 0.04 to 0.07), which was similar to the Putey walk ($\dot{V}O_2$: 12.3±1.8 mL/kg/min, 95% confidence interval 10.9 to 13.4; EE: 0.06±0.01 kcal/kg/min, 95% confidence interval 0.05 to 0.07; fig 1 and fig 2). Indeed, all 13 participants had greater $\dot{V}O_2$ and EE during the Teabag walk compared with both their usual walk and the Putey walk, with increases in $\dot{V}O_2$ ranging from 9.9 to 24.1 mL O_2/min/kg, and increases in EE ranging from 0.05 to 0.12 kcal/kg/min (fig 1 and fig 2). The similarity in $\dot{V}O_2$ and EE for the Putey walk and participants' usual walk is because of the very slow speed of the Putey walk (1.76±0.41 kilometers per hour (kph)). The speed of the Teabag walk (3.27±0.75 kph) was also significantly slower than the usual walking speed (3.94±0.67 kph).

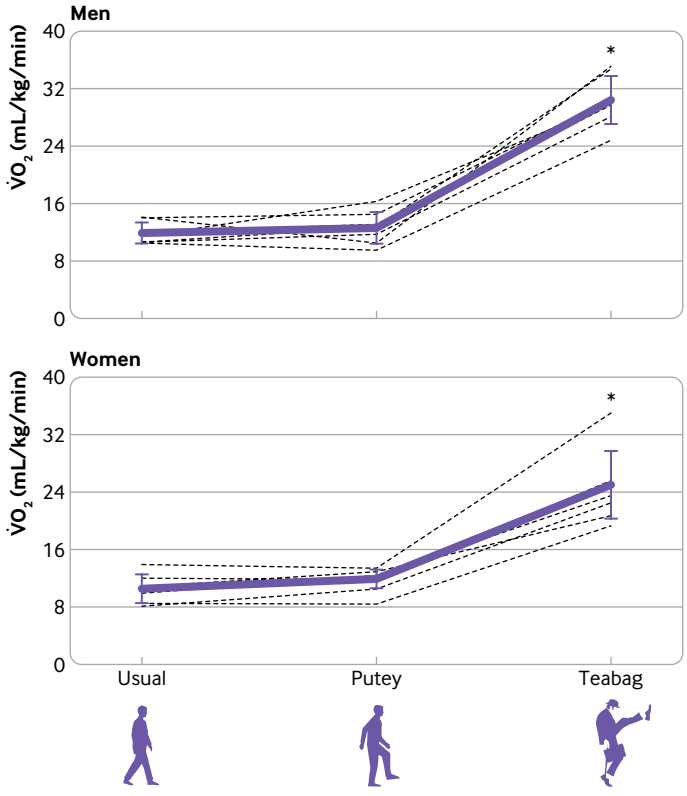

Fig 1 | Oxygen uptake ($\dot{V}O_2$; mL/kg/min) during participants' usual walking and inefficient walking in men and women. Black lines are responses for individual participants. Purple line is mean±standard deviation. *Significantly greater than participants' usual walking and the Putey walk for combined data (men and women; P<0.001)

For our participants, exchanging one minute of walking in their usual style with one minute of Teabag walking increased EE by an average of 8.0 kcal/min for men and 5.2 kcal/min for women (table 2). Table 2 also provides estimates of increased EE (kcal/min) associated with Teabag walking for a total of 10, 20, and 30 minutes for women and men with the mean body mass of our participants.

For all three walks, EE (kcal/min) was significantly correlated with body mass (fig 3). Compared with walking in their usual style, the additional EE of the Teabag walk was about twofold greater for the heaviest participants (increase of ~10 kcal/min) compared with the lightest participants (increase of ~5 kcal/min).

We did not measure minutes spent laughing or number of smiles as secondary outcomes while walking inefficiently. Smiling during the inefficient walking trials could not be observed due to participants' mouths being obscured by the facemask worn during data collection. However, all participants were noticeably smiling upon removal of the facemask. Moreover, bursts of laughter from the participants were frequently noted by the supervising investigator, almost always when participants were engaging in the Teabag walk.

Discussion

The higher EE during the Teabag walk (~2.5 fold) would amount to a substantially greater energy expenditure even if only practiced for a few minutes each day. Following sound PEMPA principles, for our participants the higher EE (~5-8 kcal/min) could increase total daily EE by about 50-80 kcal if practiced for just 10 min/day, and by about 150-240 kcal if practiced for up to 30 min/day. As you might expect, EE was positively correlated with body mass for all walks completed in this study, and most pronounced for the Teabag walk. In other words, the heavier the person, the more energy expended during an inefficient walk.

A strong body of evidence supports the health benefits conferred by meeting the threshold of 150 minutes of moderate activity or 75 minutes of vigorous intensity exercise per week (or equivalent), including reduced risk of all cause mortality.[16] The average $\dot{V}O_2$ during the Teabag walk was 30.4 mL O_2/kg/min or about 8.7 resting metabolic equivalents (METs; 1 MET=3.5 mL O_2/kg/min) for male participants, and 25.0 mL O_2/kg/min (~7.1 METs) for female participants. These data exceed the MET threshold for vigorous intensity exercise for adults, and exercise at these intensities is known to increase cardiorespiratory fitness.[17] Adults could therefore achieve 75 minutes of vigorous intensity physical activity per week by

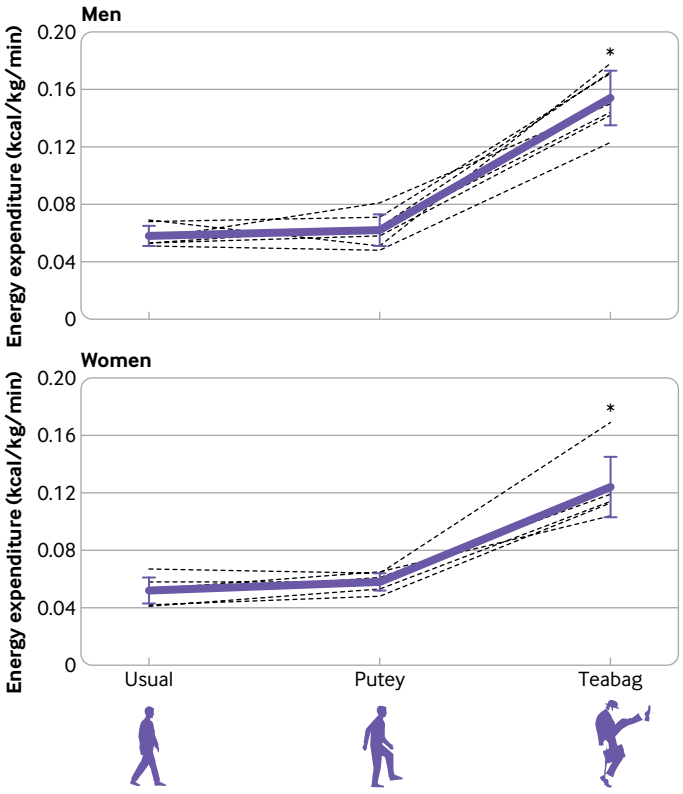

Fig 2 | Energy expenditure (kcal/kg/min; 1 kcal=4.18 kJ) during participants' usual walking and inefficient walking in men and women. Black lines are responses for individual participants. Purple line is mean±standard deviation. *Significantly greater than participants' usual walking and the Putey walk for combined data (men and women; P<0.001)

walking in Teabag style for about 11 min/day. This would very likely increase cardiorespiratory fitness, though that is as yet untested. This amount of walking in Teabag style would also likely reduce mortality risk, as 60 min/week (~9 min/day) of vigorous intensity physical activity is associated with a lower risk of all cause mortality of about 10%.[18]

When increasing energy expenditure by participating in a structured exercise programme, many adults will downregulate time spent in spontaneous physical activity.[19] Inefficient walking, in its embrace of PEMPA, does not add to total time spent being physically active, but replaces lower energy, more efficient activity (one's usual walking) with higher energy, lower efficiency movement. Data from 717 527 people across 111 countries indicate that adults average approximately 5000 steps/day.[20] Using 90 steps/min as a medium walking pace for adults,[21] which is close to the average step rate for the Teabag walk, replacing about 1100-1700 usual style steps (~22%-34% of total daily steps) with Teabag style steps would increase daily energy expenditure by approximately 100 kcal and could be achieved in around 12-19 min/day. Any joy derived from inefficient walking would further promote its uptake.

Limitations and considerations for future investigation

The small sample is a limitation. Still, every participant's $\dot{V}O_2$ during the Teabag walk was at least 2.3 times greater than during their usual walk, strongly supporting that this is generalizable to most adults. Although our study did not include young people or people with atypical gait, physical disabilities, or movement disorders, the principle of increasing metabolic intensity of movement by making it less efficient is intuitive and likely to hold true across a range of populations.

We did not address the sustainability of—or participants' endurance for—inefficient walking. But it is important to note that the EE of exercise is the same whether performed all at one time or distributed throughout the day,[22] and cardiovascular benefits similarly accrue when daily recommended amounts of exercise are completed in multiple short bouts.[17] Bursts of physical activity as short as one to two minutes, accumulated over time, can produce cardiovascular benefits.[23] As such, people could engage in periodic bursts of inefficient walking, perhaps lasting only a few minutes at a time, at times and places that are most convenient for them. In fact, inefficient walking can be performed entirely indoors. This might appeal to those who live in places where outdoor spaces for recreation are inaccessible or unsafe, or indeed to people who are hesitant to engage in inefficient walking in public.

Some people, including those with disabilities, gait disorders, joint disease, or other health conditions,

Table 2 | Differences in energy expenditure (EE) between participants' usual walk and Teabag walking for study participants

	Men (n=7)		Women (n=6)	
	Participants' usual walk	Teabag walk	Participants' usual walk	Teabag walk
EE (kcal/kg/min)*	0.058	0.154	0.052	0.124
Difference in EE (kcal/kg/min; Teabag – usual walk)	0.096		0.072	
Mean body mass (kg)	83.5		72.1	
Increased EE of Teabag walk for men and women†				
1 minute	8.0		5.2	
10 minutes	80		52	
20 minutes	160		104	
30 minutes	240		156	

1 kcal=4.18 kJ.
*EE (energy expenditure) values are the mean values for each walk.
†Based on mean body mass of participants (total kcal (difference in EE×body mass)).

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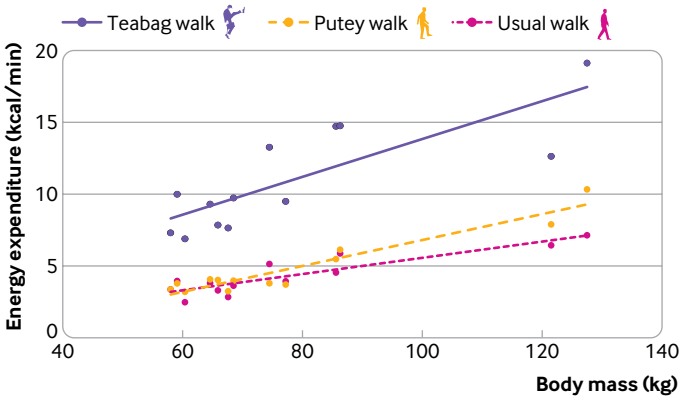

Fig 3 | Association between energy expenditure (kcal/min; 1 kcal=4.18 kJ) and body mass (kg) for participants' usual walking, the Putey walk, and the Teabag walk. Pearson correlations (r) and 95% confidence intervals: participants' usual walking (r=0.90, 95% confidence interval 0.68 to 0.97); Putey walk (r=0.95, 95% confidence interval 0.85 to 0.99); Teabag walk (r=0.81, 95% confidence interval 0.46 to 0.94)

might not be able to perform the Putey or Teabag walks depicted in the MoSW skit and assessed in this study. But they might be able to otherwise increase EE in their daily movements, with inefficiency as the goal. This could be applied to people using walkers, crutches, or wheelchairs (eg, not moving in boring straight lines). All of these possibilities require additional research to determine efficacy and feasibility.

At present, we cannot advocate generalizing the findings of this research and general suggestion to decrease efficiency in movement to other forms of exercise such as mountaineering, water sports (except aquatic aerobics), or urban cycling. Inefficient dancing has been around for generations but, too often, that lone innovator at your local nightclub or on your cruise ship has been the subject of derision rather than justifiable admiration (with the notable exception of break dancing).

Inefficient walking constitutes high intensity exercise that, as for other forms of aerobic exercise, could evoke the neuroendocrine phenomenon known as runner's high, motivating some people to partake in regular physical activity.[16 24] Whether smiles and laughter observed during inefficient walking is due to a walker's high is an important question that remains to be investigated.

Lastly, we acknowledge that widespread inefficient walking by able bodied people might have untoward psychological effects on people with atypical gait or disabilities. There is an unfortunate history in comedy of able bodied people mocking people with disabilities, atypical gait, or movement disorders. Our analysis of the energy consumed during different styles of walking seeks to empower people to move their own bodies in more energetic—and hopefully joyful—ways. If inefficient walking were to become the focus of a public health campaign, it would be essential to promote it in a way that is sensitive and respectful to people with atypical gaits and people with disabilities. The How I Walk movement to "rebrand the word 'walking' by challenging individual and societal perspectives", started by the National Center on Health, Physical Activity and Disability in the United States (https://www.nchpad.org/howiwalk/), might serve as a model.

Conclusions

Half a century ago, the MoSW skit might have unwittingly touched on a powerful way to enhance cardiovascular fitness in adults. Increasing the inefficiency of physical activity and movement that we already perform (thereby requiring no further time commitment) might complement other public health efforts to promote regular physical activity in a joyful way. Efforts to boost cardiovascular fitness should embrace inclusivity and inefficiency for all.

Contributors: GAG conceived and designed the study with DCP and SSA. GAG obtained Institutional Review Board approval and conducted all experimental procedures. GAG and SSA performed statistical analyses. All authors were involved in the initial drafting and editing of the manuscript, and approved the final version before submission. The corresponding author is the guarantor and attests that all listed authors meet authorship criteria and that no others meeting the criteria have been omitted.

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Competing interests: All authors have completed the ICMJE uniform disclosure form at www.icmje.org/disclosure-of-interest/ and declare: no support from any organization for the submitted work; no financial relationships with any organizations that might have an interest in the submitted work in the previous three years; no other relationships or activities that could appear to have influenced the submitted work.

Ethical approval: This study was approved by the Arizona State University Institutional Review Board (IRB No STUDY00008658).

Data sharing: Deidentified raw data are available upon reasonable request.

The lead author (GAG) affirms that the manuscript is an honest, accurate, and transparent account of the study being reported; that no important aspects of the study have been omitted; and that any discrepancies from the study as planned (and, if relevant, registered) have been explained.

Dissemination to participants and related patient and public communities: Participants in this study were informed of their own results at the time of their laboratory visit. We intend to share our results with the wider community via social media, educational meetings, and press release.

Provenance and peer review: Not commissioned, externally peer reviewed.

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