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Individualized Estimation of Physical Activity in Older Adults with Type 2 Diabetes

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Abstract

Purpose—Compare physical activity intensity in older adults with T2DM using individualized, relative cutpoints with standard, absolute cutpoints.

Methods—One hundred older adults with T2DM (68.9 ± 5.1 y, 65% male, 32.7 ± 6.3 kg·m⁻², 7.2 ± 1.1 % HbA1c) completed a two-speed walking protocol (varying, walking between 1–2.5 mph), followed by a modified Bruce peak exercise test. Participants wore an accelerometer-based physical activity monitor at their waist and oxygen consumption was measured. Afterwards, participants wore the activity monitor for 7 consecutive days. Linear equations for each individual was derived from the activity counts and energy expenditure measured during the walking protocol. Relative intensity cutpoints were calculated by using standard classifications of 44% VO_{2peak} to determine moderate and 59% VO_{2peak} to determine vigorous intensity. Average time spent in intensity categories per day were calculated using relative and absolute (moderate 2020 cpm, vigorous 5999 cpm) cutpoints. T-tests were run to compare estimated time spent in intensity category by cutpoint.

Results—Mean VO_{2peak} was 17.9 ± 4.5 ml·kg⁻¹·min⁻¹ and relative cutpoints were, on average, 1033.5(SD=741.2) cpm for moderate and 2211.7(SD=1512.4) cpm for vigorous activity. Using the relative cutpoints, participants accumulated an average of 157.2(SD=73.7) min of light, 33.3(SD=35.6) min of moderate, and 15.6(SD=26.7) min of vigorous activity per day. Use of the absolute cutpoint resulted in significantly different estimations based on intensity category: light

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Conflicts of Interest

The authors have no conflicts of interest.

200.7(SD=74.7, $p<0.05$) min, moderate 7.1(SD=9.2, $p<0.05$) min, and vigorous 0.006(SD=0.04, $p<0.05$) min of activity per day.

Conclusion—These results suggest utilization of absolute cutpoints may underestimate daily relative intensity levels of physical activity in older adults with T2DM. This misclassification may improperly inform dose-response relationships, and population-based prevalence of physical activity in these and may extend to other clinically important populations.

Keywords

aging; activity monitor; exercise; surveillance; accelerometer

Introduction

In the United States only 13.1% of older adults meet physical activity recommendations (8). The prevalence of active older adults with type 2 diabetes mellitus (T2DM) is even lower, with less than 10% meeting recommendations for health benefit (9.1%) (8). Due to these low activity rates and given the vast health benefits to be physically active (4), enhancing physical activity in inactive, older adults especially those with T2DM is critical.

Optimizing the accuracy and precision of measuring physical activity intensity when using accelerometer-based physical activity monitors in older adults and those with clinical disease is of high importance. Previous research has shown the use of standard, absolute intensity cutpoints to classify activity monitor data may underestimate the prevalence of meeting physical activity guidelines in older adults or those with chronic conditions (14). It has been suggested individualized, relative intensity cutpoints may provide a better estimate of physical activity intensity for older adults or those with low fitness levels (11, 13). In 2010, Miller and colleagues published individually derived accelerometer cutpoints based on age (11). Results indicate there were significant differences in calculated physical activity intensity cutpoints based on absolute intensities (metabolic equivalent) compared with relative intensities (percent VO_{2max}). Similarly, Ozemek et al. compared individual and relative cutpoints between adults with low, moderate, and high fitness groups (13). Authors found cutpoints for the same intensity category significantly increased as fitness level increased. Therefore, these studies provide evidence of a possible benefit of using relative cutpoints in an older adult population, those with a low fitness level, and those with chronic comorbidities.

Previous research has shown the development of relative intensity cutpoints and compared the difference in relative and absolute cutpoint values among heterogeneous populations (11, 13). However, no study has tested and discussed the implications for applying these cutpoints to group-level data and examined the physical activity outcomes. The difference in how we operationalize measurement methods into minutes per day of physical activity has already proved challenging, for example when comparing population estimates of Americans meeting physical activity guidelines from the National Health and Nutrition Examination Survey (NHANES), 3.5% of the population meeting physical activity guidelines and the Behavioral Risk Factor Surveillance Survey (BRFSS), 51.6% of the population meeting physical activity guidelines (5, 15). The NHANES population data were

reduced using now standard, absolute intensity accelerometer cutpoints, whereas the BRFSS is a questionnaire-based measurement that is considered a relative intensity assessment. Further complicating matters, when we extrapolate these surveillance results to categorize people as either 1) meeting or 2) not meeting guidelines we do so using the physical activity guidelines that were developed on the absolute intensity scale from observational studies (4). Therefore, it is unknown whether these newly developed relative intensity cutpoints will apply or should be applied to an older adults population with type 2 diabetes.

To date, no study has compared the application of absolute intensity and relative intensity cutpoints to estimate physical activity intensity in an insufficiently active, older adult population with T2DM. The purpose of this study is to describe the amount of time older adults with T2DM spend in different physical activity intensities when using relative cutpoints and using absolute cutpoints.

Methods

Participants

Men and women 60 years or older who were insufficiently active (less than three times a week of 30 minutes of at least moderate intensity physical activity, five days per week) and had been diagnosed with T2DM were recruited to participate in a randomized exercise training trial. T2DM diagnosis was determined by medical history and medication use. Potential participants were excluded if they had active medical conditions that might compromise independent exercise such as cardiopulmonary conditions or musculoskeletal conditions that severely limited weight-bearing activity. Those who could not maintain safe, independent stance and walking, with or without an assistive device, were also excluded. Participants were recruited by posting flyers at local hospitals, medical clinics and senior centers, local community newspaper advertisements, a University research participant recruitment website, a University diabetes research registry, and the research participant program at a University Geriatrics Center. A total of 1,974 individuals were contacted for participating with 152 agreeing to participate. Of those, three were determined ineligible at time of the first study visit and five dropped out after initial history and stress test. Prior to study participation, all participants provided written informed consent approved by the Institutional Review Board.

Overview

Participants completed a two-stage submaximal walking protocol on a treadmill followed by a graded, peak exercise test on a treadmill. During the treadmill testing participants wore an activity monitor at their waist and oxygen consumption was measured using a portable metabolic system. Afterwards, participants were asked to wear the activity monitor for a consecutive 7-day period. A linear equation for each individual was derived from the activity counts and energy expenditure measured during the walking protocol.

Treadmill Walking Test

Participants were asked to walk on a treadmill (Trackmaster TM500E) for two, four-minute submaximal stages. Speeds for these two stages ranged between 1.0 and 2.5 mph,

customized to the individual, with the second stage being of greater speed than the first stage by 1 mph. Average(SD) VO_2 from the walk test are presented in Table 1. This walking test was purposefully added to the study protocol however; it was additionally used as a warm-up for the graded exercise test, which followed. Therefore, the protocol for the walking test was developed in line with ACSM guidelines for graded exercise testing warm-ups for older adults with chronic disease as not to physically exhaust participants prior to performing the graded exercise test (2).

Treadmill Graded Exercise Test

Directly following this two stage submaximal testing, participants completed a graded exercise test to volitional exhaustion, following a modified Bruce protocol that focused mainly on changes in elevation (1). Speed was kept constant throughout the test and treadmill incline was increased 2% every 2 minutes.

Metabolic System

The Cosmed K4b² portable metabolic system (Cosmed, Inc., Rome, Italy) was used to measure oxygen consumption (VO_2) continuously during the treadmill testing. The Cosmed K4b² is a lightweight portable metabolic system that was worn on a chest harness. Volume of expired air and concentration of oxygen and carbon dioxide collection are collected through a fitted facemask (Hans Rudolf, Inc., Kansas City, MO) covering the participants' nose and mouth and a head strap to secure to the head. The K4b² has shown to be valid and reliable to measure VO_2 during rest and exercise in adults (10, 16). Cosmed data were downloaded to a laboratory computer and averaged over 1-minute. $\text{VO}_{2\text{peak}}$ was determined by the highest VO_2 minute value during the graded exercise test.

Activity Monitor

Actigraph GT3X+ activity monitors were worn during the treadmill tests and the 7-day observation period. All monitors were worn on the right hip in line with the middle of the thigh. During the 7-day observation, participants were instructed to wear the activity monitor all waking hours and to remove the monitor if they were to be submerged in water (i.e. swimming, bathing). In addition, they completed a wear log to record when they put on and took off the monitor. Upon download, activity monitor data were totaled into 1-min epochs. For the 7-day observation period, wear time was determined using the wear logs and the Choi algorithm (7). The absolute cutpoint used for analysis was the published Troiano cutpoint (15). Relative cutpoints were calculated using rest and the submaximal and peak walks. Average cpm and VO_2 for rest and each submaximal walk stage were calculated (excluding the first two min of each) for each individual. Given the known linear relationship between counts and movement we developed a three-point linear calibration and extrapolated this to max using measured peak VO_2 , thus developing a linear equation from rest to maximum for each individual between accelerometer counts and measured VO_2 (12). Relative intensity cutpoints were calculated by using 44% $\text{VO}_{2\text{peak}}$ to determine moderate and 59% $\text{VO}_{2\text{peak}}$ to determine vigorous intensity (4).

Statistical Analyses

All statistical analyses were done in SPSS version 23 (IBM Corp., Armonk, NY). Descriptive statistics were used to for participant characteristics and are presented as means and standard deviation. All data used for analyses were checked for normality. We tested for differences in estimated time spent in intensity category as calculated from the absolute cutpoints and the relative cutpoint using a paired sample t-test.

Results

Participants (N=100) were on average ($\pm$ SD) 68.9 $\pm$ 5.1 y, had a body mass index of 32.7 $\pm$ 6.3 kg·m⁻², HbA1c at 7.2 $\pm$ 1.1%, 65% male, 80% White, 18% Black, and 2% other (Table 2). All participants were on a prescription medication, taking an average of 6 $\pm$ 3 prescription medications with 99% of participants taking an endocrine medication and 100% taking a cardiovascular medication. The average calculated relative cutpoint for moderate intensity activity was 1034 $\pm$ 741 cpm, based on VO_{2peak} data. The average calculated relative cutpoint for vigorous intensity activity was 2212 $\pm$ 1512 cpm.

Figure 1 depicts the importance of investigating the use of relative cutpoints in this population. The red horizontal lines demarcate the relative moderate (933 cpm) and vigorous cutpoint (1452 cpm) for this sample participant. The black horizontal lines demarcate the absolute (Troiano) moderate (2020 cpm) and vigorous (5999 cpm) intensity cutpoints. Figure 1 shows one day of activity from the participant and illustrates the incongruences in moderate and vigorous minutes throughout the day, dependent on the cutpoint chosen for analysis (absolute vs relative).

On average, when absolute cutpoints were used, participants engaged in 200.7 $\pm$ 74.7 min of light intensity, 7.1 $\pm$ 9.2 min of moderate intensity, and 0.01 $\pm$ 0.03 min of vigorous intensity physical activity per day (Figure 2). In contrast, when relative, cutpoints were used, participants engaged in 157.2 $\pm$ 73.7 min of light intensity, 33.3 $\pm$ 35.6 min of moderate intensity, and 15.6 $\pm$ 26.7 min of vigorous intensity physical activity per day (Figure 2). The comparison between absolute and relative cutpoints revealed significant differences at all intensities (p <0.05). Overall, absolute cutpoints resulted in classifying 11% of the participants as meeting physical activity guidelines, while relative cutpoints classified 63% of participants as meeting physical activity guidelines (Table 2).

Finally, descriptors for participants grouped by those meeting the United States Department of Health and Human Services physical activity guidelines versus not meeting physical activity guidelines were examined for differences (4). Table 2 shows there were significant differences in VO_{2peak} between those participants meeting activity guidelines and those not meeting guidelines when absolute cutpoints are used. The difference in relative moderate and vigorous cutpoints between those who met versus those who did not meet the guidelines was particularly pronounced. Additionally, when comparing the difference in characteristics between those meeting guidelines according to absolute classification and those meeting guidelines according to relative classification there was a significant difference between VO_{2peak}. There were no other significant differences in descriptive variables between participants meeting and not meeting guidelines.

Discussion

When evaluating time spent in light, moderate, and vigorous intensity physical activity consideration should be given to known influencers of maximal aerobic capacity such as sex, age, training state, and health status (2). Previous research has examined the influence of age and training state on the use of generalized activity monitor intensity classifications and have reported differences in cutpoint generation when individualized cutpoints are developed, relative to the participants' maximal aerobic capacity (11, 13). However, no study has applied this individualized, relative cutpoint approach and compared the resultant time spent in intensity categories with the results from generalized, absolute cutpoints.

The current study revealed there was a significant difference in time spent in each intensity category by activity monitor reduction method used: absolute cupoints versus relative cutpoints. With the use of relative intensity cutpoints, time spent in light intensity was significantly less, with a greater than threefold increase in time spent in moderate and vigorous intensity. This has direct implications for public health messaging, determinants of physical activity and health, and program development in older adults, older adults with low aerobic capacities, and as shown in this study, older adults with T2DM. For example, national prevalence data suggests less than 5% of our adult population meet physical activity guidelines using absolute cutpoints to identify activity (15). Subsequently, these same cutpoints are then used to characterize the relation between physical activity and health (3, 9). Therefore, these studies may be misrepresenting the activity levels and health links within a portion of their population.

The differences in time spent in each intensity are directly impacted by the change in cutpoints due to differences in individual VO_{2peak} values. This is consistent with results seen in the two previous studies that have provided foundational evidence for the importance of calculating relative intensity cutpoints in certain populations. Miller and colleagues calculated relative intensity cutpoints across age (20–69 yrs). Authors found there was a 2000 cpm difference in the light to moderate cutpoints for 60 yr old adults and older compared to the younger participants (11). Similarly, Ozemek and colleagues examined differences in cutpoints when maximal aerobic capacity was taken into account (13). They also found a significant difference in intensity cutpoints when calculated for low fit, moderate fit, and high fit groups of adults. However, when studies are compared there is little overlap in summarized results, for our population the average moderate intensity relative cutpoints was 1034 ± 741 cpm, while the lowest fitness group (<10 METS) in Ozemek and colleagues' population's average moderate relative cutpoint was 3385 ± 850 cpm; three times greater. Differences were likely due to our population being much older and much more unfit (average $VO_{2peak} = 17.9$ ml/kg/min). More similar to our results, Miller et al. presented an average moderate relative cutpoint for adults 60–69y at 1566 cpm.

These study results illustrate an important conundrum in the current physical activity measurement area and highlights the limitations to using absolute intensity based cutpoints. The alternative to the classic cutpoint approach may be using a more individualized cutpoint, taking into account an individual's maximal aerobic capacity, which may not always be feasible. Future work should identify ways of feasibly evaluating these individual factors

that would affect maximal aerobic capacity and in turn providing guidance for identifying moderate and vigorous intensity cutpoints in patient populations.

Another critical point for discussion is highlighted in Table 2. When relative intensity cutpoints are used, over 60% of our sample meet physical activity guidelines for health. However, when we examine the absolute intensity cutpoints, only 11% of the sample is meeting physical activity guidelines. The implication of this discrepancy between the two accelerometer reduction processes is alarming. If we are to believe the relative intensity classification as “truth”, the individuals who are being classified as meeting physical activity guidelines with the absolute cutpoints are actually engaging in 150 minutes per week at an intensity greater than moderate. This begs the question whether the intensity level for the physical activity guidelines for health when applied to accelerometer data should be different than have been originally defined.

Over the years researchers have attempted to identify solutions to the known individual variation in absolute intensity, such as the 1996 Surgeon General Report on Physical Activity and Health and Howley who have both reported metabolic equivalent values taking into account personal characteristics that can influence VO_{2max} , such as age or fitness status (4, 6). Even with these efforts, moving forward, we must acknowledge the clear discrepancy between the physical activity guidelines development method and current study measurement methods. These discrepancies also raise the question of the appropriateness of continuing to utilize self-report based guidelines with the advent of accelerometer use especially in population-based studies. For example NHANES estimates (3.5%) versus BRFSS estimates (51.6%) of the American population meeting physical activity guidelines (5, 15). These results lead to important future research questions including addressing this discrepancy between the physical activity guidelines development method and new study measurement methods, such as accelerometry, and the identification of potential accelerometer-measured specific physical activity guidelines.

Finally, we must also keep in mind the translatability of the message for general population consumption. From the public health perspective, we need to examine how we can clearly prescribe physical activity (relative versus absolute recommendations) in order to incorporate all populations (young/old, fit/unfit, health/unhealthy) and make the guidelines easy to consume, comprehend, and enact. We need to also consider if overarching population guidelines are possible. Future research should continue to build on these findings, due to our study population - all diagnosed with a chronic disease, differentiation between health variables is limited therefore further applying this approach to a larger and more diverse data set and understand the impact of using relative versus absolute outcomes.

A limitation to the current study was the inclusion of participants with comorbidities and those who were currently taking beta-blockers. However, the purpose was to devise a relative analysis, these factors would contribute to their calculation and not affect others calculations as the cutpoints are not meant to be generalized. The strengths of the current study included the direct measurement of VO_{2peak} in order to calculate an actual relative intensity for each participant, and the rich dataset which allowed multiple covariates to be considered within the analysis.

Conclusion

These results suggest utilization of absolute intensity cutpoints may underestimate daily relative intensity levels of physical activity in older adults with T2DM. This misclassification may bias true dose-response relationships, and population-based prevalence of physical activity in older adults with T2DM and other clinically important populations. These misclassifications could also inaccurately inform future intervention work in inactive, older adults with T2DM. Future work should identify a feasible way to assess what older or comorbid adults would consider moderate to high intensity physical activity, preferably without the need for formal peak treadmill testing. Even more important would be to examine the effect of relative intensity-derived analyses on health-related dose-response and intervention outcomes.

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References

1. Alexander NB, Dengel DR, Olson RJ, Krajewski KM. Oxygen-uptake (VO₂) kinetics and functional mobility performance in impaired older adults. *J Gerontol A Biol Sci Med Sci*. 2003; 58(8):734–9. [PubMed: 12902532]
2. American College of Sports Medicine. ACSM's Resource Manual for Guidelines for Exercise Testing and Prescription. 6. Baltimore, MD: Lippincott, Williams, & Wilkins; 2014. p. 290
3. Atienza AA, Moser RP, Perna F, et al. Self-reported and objectively measured activity related to biomarkers using NHANES. *Med Sci Sports Exerc*. 2011; 43(5):815–21. [PubMed: 20962693]
4. Center for Disease Control and Prevention. Physical activity and health: a report of the surgeon general. DIANE Publishing; 1996. p. 33
5. Centers for Disease C, and Prevention. Adult participation in aerobic and muscle-strengthening physical activities--United States, 2011. *MMWR Morb Mortal Wkly Rep*. 2013; 62(17):326–30. [PubMed: 23636025]
6. Howley ET. Type of activity: resistance, aerobic and leisure versus occupational physical activity. *Med Sci Sports Exerc*. 2001; 33(6 Suppl):S364–9. discussion S419–20. [PubMed: 11427761]
7. Keadle SK, Shiroma EJ, Freedson PS, Lee IM. Impact of accelerometer data processing decisions on the sample size, wear time and physical activity level of a large cohort study. *BMC Public Health*. 2014; 14:1210. [PubMed: 25421941]
8. Loprinzi PD. Accelerometer-determined sedentary and physical activity estimates among older adults with diabetes: considerations by demographic and comorbidity characteristics. *J Aging Phys Act*. 2014; 22(3):432–40. [PubMed: 24084172]
9. Loprinzi PD, Lee H, Cardinal BJ. Evidence to Support Including Lifestyle Light-Intensity Recommendations in Physical Activity Guidelines for Older Adults. *Am J Health Promot*. 2014; 29(5):277–84. [PubMed: 24575724]
10. McLaughlin JE, King GA, Howley ET, Bassett DR Jr, Ainsworth BE. Validation of the COSMED K4 b2 portable metabolic system. *Int J Sports Med*. 2001; 22(4):280–4. [PubMed: 11414671]

11. Miller NE, Strath SJ, Swartz AM, Cashin SE. Estimating absolute and relative physical activity intensity across age via accelerometry in adults. *J Aging Phys Act.* 2010; 18(2):158–70. [PubMed: 20440028]
12. Montoye HJ, Washburn R, Servais S, Ertl A, Webster JG, Nagle FJ. Estimation of energy expenditure by a portable accelerometer. *Med Sci Sports Exerc.* 1983; 15(5):403–7. [PubMed: 6645869]
13. Ozemek C, Cochran HL, Strath SJ, Byun W, Kaminsky LA. Estimating relative intensity using individualized accelerometer cutpoints: the importance of fitness level. *BMC Med Res Methodol.* 2013; 13:53. [PubMed: 23547769]
14. Strath SJ, Pfeiffer KA, Whitt-Glover MC. Accelerometer use with children, older adults, and adults with functional limitations. *Med Sci Sports Exerc.* 2012; 44(1 Suppl 1):S77–85. [PubMed: 22157778]
15. Troiano RP, Berrigan D, Dodd KW, Masse LC, Tilert T, McDowell M. Physical activity in the United States measured by accelerometer. *Med Sci Sports Exerc.* 2008; 40(1):181–8. [PubMed: 18091006]
16. Welch WA, Strath SJ, Swartz AM. Congruent validity and reliability of two metabolic systems to measure resting metabolic rate. *Int J Sports Med.* 2015; 36(5):414–8. [PubMed: 25700097]

Figure 1.

Example of a single participant's day with intensity categories defined by absolute (black lines) and relative (red lines).

Footnote: IC individualized, relative cutpoint, Reference: Troiano RP, Berrigan D, Dodd KW, Masse LC, Tilert T, McDowell M. Physical activity in the United States measured by accelerometer. *Med Sci Sports Exerc.* 2008 Jan;40(1):181-8.

Figure 2.

Mean (SE) physical activity intensity minutes per day estimates from absolute intensity (black) and relative intensity (grey) cutpoints (* $p < 0.05$).

Footnote: Relative are the individualized cutpoints, averages were as follows Light: 101–1033 counts per min, Moderate: 1034 ± 741 counts per min, Vigorous: $>2211 \pm 1512$ counts per min. Absolute cutpoints were as follows Light: 101–2019 counts per min, Moderate: 2020–5999 counts per min, Vigorous >6000 counts per min.

Table 1Mean and standard deviation of VO₂ during exercise testing

	VO ₂ (ml/kg/min)	
	Mean	SD
Stage 1	7.9	2.4
Stage 2	12.0	2.6
Graded Exercise Test	17.8	4.4
44% VO ₂	7.8	1.9
59% VO ₂	10.5	0.9

VO₂ oxygen consumption

Table 2

Participant Characteristics (Mean(SD)) of the total sample and those meeting and not meeting physical activity guidelines by cutpoint

	Absolute Cutpoint Classification*			Relative Cutpoint Classification			Comparison of those meeting PAG (a & b) (p-value)
	Overall (N=100)	Meeting PAG ^a (n=11)	Not Meeting PAG (n=89)	p-value	Meeting PAG ^b (n=63)	Not Meeting PAG (n=37)	
Age (yrs)	68.9(5.1)	67.2(4.1)	69.1(5.1)	0.289	69.1(5.1)	68.5(5.1)	0.57
% Male	65	88.9	61.8		58.7	75.7	
BMI (kg·m ⁻²)	32.7(6.3)	31.5(7.5)	32.6(5.9)	0.586	33.3(6.8)	31.6(5.2)	0.213
HbA1c (%)	7.2(1.1)	6.7(1.0)	7.2(1.1)	0.193	7.1(1.1)	7.4(1.1)	0.261
VO _{2peak} (ml/kg/min)	17.9(4.5)	22.9(6.2)	17.6(4.1)	0.034	17.7(4.7)	18.5(4.2)	0.383
IC Moderate Cutpoint (cpm)	1033.52(741.2)	1468.1(829.1)	996.6(728.3)	0.71	675.6(332.4)	1643.0(845.4)	<0.001
IC Vigorous Cutpoint (cpm)	2211.7(1512.4)	3226.4(1458.8)	2090.9(1468.3)	0.029	1688.5(1254.3)	3102.5(1512.5)	<0.001

BMI body mass index, HbA1c glycosylated hemoglobin, VO_{2peak} peak oxygen consumption, IC individualized cutpoint, cpm counts per minute,

* reference (12), PAG physical activity guidelines reference (10)