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Bouted and non-bouted moderate-to-vigorous physical activity with health-related quality of life

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ABSTRACT

Examine the association between bouted (10+ minutes in duration) and non-bouted (<10 minutes in duration) moderate-to-vigorous physical activity (MVPA) with health-related quality of life (HRQOL).
Data from the 2003–2006 NHANES were used (20+ years; N = 5530). Participants wore an ActiGraph 7164 accelerometer over a period of up to 7 days to assess accumulation in bouted and non-bouted MVPA. From 4 self-reported items, HRQOL was assessed using the CDC HRQOL-4 questionnaire, with a higher HRQOL-4 score indicating worse HRQOL.
In a single multivariable ordinal regression analysis, both non-bout ($\beta_{adjusted} = -0.01$; 95% CI: −0.01 to −0.003; $P = 0.006$) and bouted ($\beta_{adjusted} = -0.08$; 95% CI: −0.15 to −0.01; $P = 0.01$) MVPA were associated with HRQOL.
Greater accumulation in both bouted and non-bouted MVPA was associated with better perceived HRQOL.

Introduction

Regular participation in physical activity is associated with reduced risk of morbidity and mortality (Kokkinos, 2012) and, not surprisingly, is associated with improved health-related quality of life (HRQOL), by way of improvements in physical functionality, vitality, mental health, and social functioning (Klavestrand and Vingard, 2009; Heath and Brown, 2009; Bize et al., 2007; Freelove-Charton et al., 2007; Kekkonen et al., 2007; Kruger et al., 2007; Mukamal et al., 2006; Pierce et al., 2006; Abell et al., 2005; Smith and McFall, 2005). To date, studies examining the physical activity-HRQOL relationship have predominately used self-report measures of physical activity. Here, in this brief report, this relationship is examined using an objective measure of physical activity to overcome the known limitations (e.g., recall bias, social desirability) of self-report physical activity methodology.

Another important novelty of this brief report is the examination of whether physical activity bout length influences HRQOL. Specifically, previous work has shown that, in addition to bouted physical activity (i.e., physical activity accrued in bouts of at least 10 minutes in duration) accumulating physical activity in shorter bout intervals (<10 minutes in duration; hereafter "non-bout") is associated with various cardiovascular disease biomarkers (Loprinzi and Cardinal, 2013) and all-cause mortality (Loprinzi, 2015). To date, the relationship between objectively measured bout and non-bout physical activity with HRQOL has not been examined to our knowledge, which was the primary purpose of this brief study.

Methods

Study design

Data from the population-based 2003–2006 National Health and Nutrition Examination Survey (NHANES) were used; these cycles were evaluated as, at the time of this writing, these are the only cycles with objectively measured physical activity data. Briefly, NHANES employs a population-based sample of Americans via household interviews and examinations in a mobile examination center. Using a multi-stage, complex probability design, non-institutionalized U.S. civilians are selected for participation. Further details about NHANES can be found on their website (http://www.cdc.gov/nchs/nhanes.htm). In the 2003–2004 cycle, the examination response rate for adults 20+ years was 68.1%; the examination response rate for the 2005–2006 cycle among adults (20 + years) was 69.8%. Ethical approval for this research was granted by the National Center for Health Statistics ethics committee.

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Measurement of physical activity

Physical activity was assessed for up to 7 days using an ActiGraph 7164 accelerometer; activity counts/min ≥ 2020 defined participation in moderate-to-vigorous physical activity (MVPA) (Troiano et al., 2008), with those having at least 4 days of 10+ hours/day of monitoring included in the analyses. Nonwear time was identified as ≥ 60 consecutive minutes of zero activity counts, with allowance for 1–2 minutes of activity counts between 0 and 100. Specific details regarding the NHANES accelerometer protocol have been previously published (Troiano et al., 2014).

Bout (≥10 minutes) and non-bout (<10 minutes) MVPA were evaluated. A 10-minute bout was defined as 10+ consecutive minutes above the MVPA cut-point, with the allowance of 1–2 minute interruption intervals (Wolff-Hughes et al., 2015; Clarke and Janssen, 2014). Non-bout MVPA was determined by the number of MVPA minutes not accrued in a bout.

Measurement of HRQOL

The CDC HRQOL measure was assessed from 4 questions, including 1 question about self-rated health status and 3 about the number of unhealthy days during the past 30 days:

1. "Would you say that in general your health is excellent, very good, good, fair, or poor?"
2. "Now thinking about your physical health, which includes physical illness and injury, how many days during the past 30 days was your physical health not good?"
3. "Now thinking about your mental health, which includes stress, depression, and problems with emotions, how many days during the past 30 days was your mental health not good?"
4. "During the past 30 days, approximately how many days did poor physical or mental health keep you from doing usual activities, such as self-care, work, or recreation?"

The 4 CDC HRQOL items were categorized according to CDC's recommendations, which included question 1 dichotomized as good/excellent health (coded as 0) or poor/fair health (coded as 1). The latter 3 items were dichotomized as 14 or more days (coded as 1) and less than 14 days (coded as 0).

Thus, the recoded 4 HRQOL items ranged from 0 to 1. An overall HRQOL score was created by summing the responses from each of the 4 individual items (range: 0–4), with higher HRQOL scores indicating worse HRQOL. The HRQOL-4 developed by CDC has undergone extensive reliability and validity testing and has demonstrated adequate psychometric properties (Jiang and Hesser, 2009; Horner-Johnson et al., 2009; Hays et al., 2009; Mielenz et al., 2006; Linden et al., 2005).

Statistical analysis

All statistical analyses were computed in Stata (v. 12) and accounted for the complex survey design of NHANES to adjust for non-compliance, non-response, and to render nationally representative estimates. A single multivariable ordinal regression was employed to examine the association between overall HRQOL (outcome variable) with bouted and non-bouted MVPA. In addition to bouted and non-bouted MVPA being included in the model, the following covariates were included: *age* (years; continuous); *gender*; *race-ethnicity* (non-Hispanic white vs. other); *self-reported smoking status* (current smoker vs. not); measured *body mass index* (kg/m^2; continuous); education attainment (college or more vs. less); *C-reactive protein* (mg/dL; continuous); and physician diagnosed *coronary artery disease* (yes vs. no). Statistical significance was established as $P < 0.05$.

Results

In the 2003–2006 NHANES, 10,020 adults (20+ years) were enrolled. Among these, 6093 adults provided sufficient accelerometry data (i.e., 4+ days of 10+ hours/day of monitoring). Among these, 5848 participants had complete data on the covariates. After excluding those with missing HRQOL data, 5530 remained, which constituted the analytic sample.

The weighted mean (SE) age of the analytic sample was 46.6 years (0.4); 51.1% were male and 73.5% were non-Hispanic white. The mean (SE) bouted MVPA was 6.7 min/day (0.3), with the weighted mean non-bouted MVPA being 17.3 min/day (0.3). For the overall HRQOL score (range: 0–4), the weighted mean was 0.38 (0.01); the weighted proportion of individuals with a score of 0, 1, 2, 3, or 4 were 74.9% (n = 3815), 16.5% (n = 1141), 5.3% (n = 362), 2.4% (n = 159), and 0.9% (n = 53), respectively.

Tertiles of bout and non-bout MVPA were created; weighted mean min/day of bouted MVPA across the bout tertiles were 0, 2.2, 17.0 min/day; weighted mean min/day of non-bouted MVPA across the non-bout tertiles were 2.7, 10.6, and 31.8 min/day. The weighted mean HRQOL (range: 0–4) score across the bout tertiles was 0.48, 0.35, and 0.25 ($P_{trend} < 0.05$). The weighted mean HRQOL scores across the non-bout tertiles were 0.64, 0.34, and 0.25 ($P_{trend} < 0.05$).

In a single weighted multivariable ordinal regression analysis, both non-bout ($\beta_{adjusted} = -0.01$; 95% CI: −0.01 to −0.003; $P = 0.006$) and bouted ($\beta_{adjusted} = -0.08$; 95% CI: −0.15 to −0.01; $P = 0.01$) MVPA were associated with HRQOL (Table 1).

Discussion

Previous work demonstrates that non-bouted MVPA (as well as bouted MVPA) is associated with cardiovascular disease biomarkers (Loprinzi and Cardinal, 2013) and all-cause mortality (Loprinzi, 2015). Likewise, research shows increases in HRQOL with physical activity engagement (Sun et al., 2014); however, the extent to which this occurs in bouted vs non-bouted MVPA is relatively unknown. In alignment with and adding to these studies, the present study also demonstrated that both non-bouted and bouted MVPA are associated with HRQOL (mean HRQOL score across the bout tertiles was 0.48, 0.35, and 0.25 and 0.64, 0.34, and 0.25 for non-bouted tertiles). However, our study showed a low level of engagement in bouted MVPA; as such, we recommend that future studies investigate new ways in which to increase population-level bouted exercise.

As mentioned elsewhere (Loprinzi, 2015), beneficial associations of non-bouted MVPA and health may have important implications as lack of time is an often cited barrier to structured exercise participation

Table 1
Weighted multivariable ordinal regression results examining the association between accelerometer-assessed bout and non-bout MVPA with HRQOL, NHANES 2003–2006 (N = 5530).

Variable	β	95% CI	P-value
Non-bout MVPA, 1 min/day increase	−0.01	−0.01 to −0.003	0.006
Bout MVPA, 1 min/day increase [a]	−0.08	−0.15 to −0.01	0.01
Covariates			
Age, 1 year increase	0.01	0.006–0.01	<0.001
Female vs. male	0.21	0.04–0.38	0.01
Non-white vs. white	0.44	0.29–0.58	<0.001
Non-smoker vs. smoker	−0.56	−0.74 to −0.38	<0.001
Body mass index, 1 kg/m^2	0.03	0.01–0.04	<0.001
College or more vs. less	−0.50	−0.66 to −0.34	<0.001
C-reactive protein, 1 mg/dL increase	0.09	0.02–0.17	0.01
Coronary artery disease vs. not	0.64	0.42–0.86	<0.001

HRQOL, health-related quality of life.
MVPA, moderate-to-vigorous physical activity.
[a] Due to non-normality, bouted MVPA was log-transformed prior to the ordinal regression model.

and non-bouted MVPA may be easier to initiate and maintain than bouted MVPA (Cardinal and Sachs, 1995; Cardinal and Sachs, 1996). Non-bouted MVPA may also be effective in increasing cardiorespiratory fitness and promoting weight loss (Schmidt et al., 2001; Jakicic et al., 1995). Of course, promotion of bouted MVPA is important, but these findings also support the promotion of non-bouted MVPA, which is not a key component of the United States Department of Health and Human Services physical activity guideline (Committee PAGA, 2008). To overcome the cross-sectional nature of the present study, future prospective work on this topic that employs an objective measure of MVPA is warranted. Additionally, future studies should also seek to employ more diverse sample regarding the HRQOL score, as 75% reported a score of zero.

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References

Abell, J.E., Hootman, J.M., Zack, M.M., Moriarty, D., Helmick, C.G., 2005. Physical activity and health related quality of life among people with arthritis. J. Epidemiol. Community Health 59 (5), 380–385.
Bize, R., Johnson, J.A., Plotnikoff, R.C., 2007. Physical activity level and health-related quality of life in the general adult population: a systematic review. Prev. Med. 45 (6), 401–415.
Cardinal, B.J., Sachs, M.L., 1995. Prospective analysis of stage-of-exercise movement following mail-delivered, self-instructional exercise packets. Am. J. Health Promot. 9 (6), 430–432.
Cardinal, B.J., Sachs, M.L., 1996. Effects of mail-mediated, stage-matched exercise behavior change strategies on female adults' leisure-time exercise behavior. J. Sports Med. Phys. Fitness 36 (2), 100–107.
Clarke, J., Janssen, I., 2014. Sporadic and bouted physical activity and the metabolic syndrome in adults. Med. Sci. Sports Exerc. 46 (1), 76–83.
Committee PAGA, 2008. Physical activity guidelines for Americans. US Department of Health and Human Services, Washington, DC, pp. 15–34.
Freelove-Charton, J., Bowles, H.R., Hooker, S., 2007. Health-related quality of life by level of physical activity in arthritic older adults with and without activity limitations. J. Phys. Act. Health 4 (4), 481–494.
Hays, R.D., Bjorner, J.B., Revicki, D.A., Spritzer, K.L., Cella, D., 2009. Development of physical and mental health summary scores from the patient-reported outcomes measurement information system (PROMIS) global items. Qual. Life Res. Int. J. Qual. Life Asp. Treat. Care Rehab. 18 (7), 873–880.
Heath, G.W., Brown, D.W., 2009. Recommended levels of physical activity and health-related quality of life among overweight and obese adults in the United States, 2005. J. Phys. Act. Health 6 (4), 403–411.
Horner-Johnson, W., Krahn, G., Andresen, E., Hall, T., Rehabilitation Training Center Expert Panel on Health Status Measurement, 2009. Developing summary scores of health-related quality of life for a population-based survey. Public Health Rep. 124 (1), 103–110.
Jakicic, J.M., Wing, R.R., Butler, B.A., Robertson, R.J., 1995. Prescribing exercise in multiple short bouts versus one continuous bout: effects on adherence, cardiorespiratory fitness, and weight loss in overweight women. Int. J. Obes. Relat. Metab. Disord. 19 (12), 893–901.
Jiang, Y., Hesser, J.E., 2009. Using item response theory to analyze the relationship between health-related quality of life and health risk factors. Prev. Chronic Dis. 6 (1), A30.
Kekkonen, R.A., Vasankari, T.J., Vuorimaa, T., Haahtela, T., Julkunen, I., Korpela, R., 2007. The effect of probiotics on respiratory infections and gastrointestinal symptoms during training in marathon runners. Int. J. Sport Nutr. Exerc. Metab. 17 (4), 352–363.
Klavestrand, J., Vingard, E., 2009. The relationship between physical activity and health-related quality of life: a systematic review of current evidence. Scand. J. Med. Sci. Sports 19 (3), 300–312.
Kokkinos, P., 2012. Physical activity, health benefits, and mortality risk. ISRN Cardiology 2012, 718789.
Kruger, J., Bowles, H.R., Jones, D.A., Ainsworth, B.E., Kohl III, H.W., 2007. Health-related quality of life, BMI and physical activity among US adults (>/=18 years): National Physical Activity and Weight Loss Survey, 2002. Int. J. Obes. 31 (2), 321–327.
Linden, W., Yi, D., Barroetavena, M.C., MacKenzie, R., Doll, R., 2005. Development and validation of a psychosocial screening instrument for cancer. Health Qual. Life Outcomes. 3, 54.
Loprinzi, P.D., 2015. Accumulated Short Bouts of Physical Activity are Associated with Reduced Premature All-Cause Mortality: Implications for Physician Promotion of Physical Activity as well as Revision of Current Government Physical Activity Guidelines Mayo Clinic Proceedings. 90(8) pp. 1168–1169.
Loprinzi, P.D., Cardinal, B.J., 2013. Association between biologic outcomes and objectively measured physical activity accumulated in >/= 10-minute bouts and <10-minute bouts. Am. J. Health Promot.: AJHP 27 (3), 143–151.
Mielenz, T., Jackson, E., Currey, S., DeVellis, R., Callahan, L.F., 2006. Psychometric properties of the Centers for Disease Control and Prevention Health-Related Quality of Life (CDC HRQOL) items in adults with arthritis. Health Qual. Life Outcomes. 4, 66.
Mukamal, K.J., Ding, E.L., Djousse, L., 2006. Alcohol consumption, physical activity, and chronic disease risk factors: a population-based cross-sectional survey. BMC Public Health 6, 118.
Pierce Jr., J.R., Denison, A.V., Arif, A.A., Rohrer, J.E., 2006. Living near a trail is associated with increased odds of walking among patients using community clinics. J. Community Health 31 (4), 289–302.
Schmidt, W.D., Biwer, C.J., Kalscheuer, L.K., 2001. Effects of long versus short bout exercise on fitness and weight loss in overweight females. J. Am. Coll. Nutr. 20 (5), 494–501.
Smith, D.W., McFall, S.L., 2005. The relationship of diet and exercise for weight control and the quality of life gap associated with diabetes. J. Psychosom. Res. 59 (6), 385–392.
Sun, K., Song, J., Lee, J., et al., 2014. Relationship of meeting physical activity guidelines with health-related utility. Arthritis Care Res. 66 (7), 1041–1047.
Troiano, R.P., Berrigan, D., Dodd, K.W., Mâsse, L.C., Tilert, T., McDowell, M., 2008. Physical activity in the United States measured by accelerometer. Med. Sci. Sports Exerc. 40 (1), 181.
Troiano, R.P., McClain, J.J., Brychta, R.J., Chen, K.Y., 2014. Evolution of accelerometer methods for physical activity research. Br. J. Sports Med. 48 (13), 1019–1023.
Wolff-Hughes, D.L., Fitzhugh, E.C., Bassett, D.R., Churilla, J.R., 2015. Total activity counts and bouted minutes of moderate-to-vigorous physical activity: relationships with cardiometabolic biomarkers using 2003-2006 NHANES. J. Phys. Act. Health 12 (5), 694–700.