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The association between bouted and non-bouted physical activity on retinopathy prevalence

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ABSTRACT

Objective: We evaluated the specific differential association between non-bouted, lifestyle physical activities (vs. structured exercise; i.e., bouted physical activity) on retinopathy prevalence among a national sample of the broader U.S. adult population.
Methods: Data from the 2005–2006 National Health and Nutrition Examination Survey (NHANES) was used to identify 1501 adults, between 40 and 85 years. Bouted and non-bouted physical activities were assessed using objective accelerometer monitoring. A 10-minute bout was defined as 10+ consecutive minutes above the moderate-to-vigorous physical activity (MVPA) cut-point, with the allowance of 1–2-minute interruption intervals. Non-bout MVPA was determined by the number of MVPA minutes not accrued in a bout. Participants were screened for non-proliferative retinopathy using Early Treatment Diabetic Retinopathy Study grading criteria, as well as objective retinal imaging assessments using the Canon Non-Mydriatic Retinal Camera CR6-45NM. Individuals were excluded if they had been diagnosed with coronary artery disease, congestive heart failure, heart attack or stroke.
Results: Participants with worse retinopathy engaged in less bouted and non-bouted physical activity, had a higher BMI and were more likely to have diabetes and hypertension. For every 1 min/day increase in non-bouted MVPA, participants had a 7% reduced odds of moderate-to-severe retinopathy compared to no retinopathy (OR = 0.93; 95% CI: 0.87–0.99; $P = 0.04$); results were similar in an unadjusted model (OR = 0.93; 95% CI: 0.89–0.97; $P = 0.007$). Bouted MVPA was not associated with retinopathy prevalence in the multivariate model.
Conclusion: In this nationally representative sample of adults, those who engaged in non-bouted physical activity had reduced odds of a diagnosis of moderate-to-severe retinopathy.

1. Introduction

Current government guidelines (USDHHS) [1] recommend individuals engage in bouts of physical activity for at least 10 min at a time, and accumulate 150 min of moderate-to-vigorous physical activity (MVPA) across a 7-day span [2]. Studies show the effects of shorter sessions of physical activity are consistent with health benefits experienced from engagement in longer exercise bouts [3]. The majority of classic physical activity epidemiology literature has focused on bouted MVPA on health outcomes. Until recently, however, little attention has been given to sporadic physical activities lasting <10 consecutive minutes [2]. Research has demonstrated that sporadic, lifestyle physical activity, or non-bouted physical activity occurring in <10-minute bouts, is independently associated with health, independent of bouted, or structured physical activity, lasting at least 10 min at a time [4–7]. Previous research has also identified a desirable, negative relationship between physical activity initiation on retinopathy incidence and pathogenesis [8–12]. To our knowledge, however, no studies have specifically investigated the impact of non-bouted (lifestyle) vs. bouted (structured exercise) physical activity on retinopathy, which is noteworthy as those with worse retinopathy may be less able to engage in structured bouted exercise. As retinopathy progresses, those affected may be unable to safely drive to sites designated for exercise, maneuver curbs or uneven terrain when walking, or require scheduled supervision of others during physical activity time, which influences feelings of social dependency and damaged self-esteem [13]. Therefore, the primary objective of this study was to elucidate the value of non-bouted physical activity participation on the diagnosis and severity of retinopathy within a nationally representative sample.

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2. Methods

2.1. Design

Data from the cross-sectional 2005–2006 National Health and Nutrition Examination Survey (NHANES) was used. Study procedures were approved by the National Center for Health Statistics ethics review board, with informed consent obtained prior to data collection. Participant retinopathy data was assessed followed by a week of accelerometry (physical activity) assessment (details described below).

The NHANES is an ongoing survey conducted by the Centers for Disease Control and Prevention that uses a representative sample of non-institutionalized United States civilians selected by a complex, multistage, stratified, clustered probability design. The multistage design consists of 4 stages, including the identification of counties, segments (city blocks), random selection of households within the segments, and random selection of individuals within the households. Further information on NHANES methodology and data collection is available on the NHANES website (http://www.cdc.gov/nchs/nhanes.htm).

2.2. Participants

The original 2005–2006 NHANES sample included 5673 participants who had retinopathy data. The analyzed sample included 1501 participants with complete data on the study variables and who also did not have a physician-diagnosis of coronary artery disease, congestive heart failure, heart attack or stroke; participants were excluded if they had these conditions as these parameters may confounded our investigated association between physical activity and retinopathy. The participants ranged in age between 40 and 85 years.

2.3. Measurement of physical activity

Physical activity was assessed for up to 7 days using an ActiGraph 7164 accelerometer, which is a sufficient amount of monitoring time to determine habitual physical activity patterns [14,15]. Activity counts/min ≥ 2020 were defined as participation in moderate-to-vigorous physical activity (MVPA) [16], with those having at least 4 days of 10+ h/day of monitoring included in the analyses. Nonwear time was identified as ≥60 consecutive minutes of zero activity counts, with allowance for 1–2 min of activity counts between 0 and 100. Specific details regarding the NHANES accelerometer protocol have been previously published [17].

Bout (≥10 min) and non-bout (<10 min) 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 [2,18]. Non-bout MVPA was determined by the number of MVPA minutes not accrued in a bout.

2.4. Retinopathy

As we have described elsewhere [9,10], retinal imaging was performed using the Canon Non-Mydriatic Retinal Camera CR6-45NM (Canon, Tokyo, Japan). The presence of non-proliferative retinopathy (mild or moderate/severe retinopathy) was determined using the Early Treatment Diabetic Retinopathy Study grading criteria [19]. As an example, severe non-proliferative retinopathy may exist if there is severe intraretinal hemorrhages, severe venous beading, or severe intraretinal microvascular abnormalities. Thus, participants were classified as no retinopathy, mild non-proliferative retinopathy or moderate-to-severe non-proliferative retinopathy.

2.5. Analysis

All statistical analyses were computed in Stata (v. 12). To maximize external validity of our findings, all analyses accounted for the complex survey design employed in NHANES. A weighted multivariable multinomial model was used, with the outcome variable being the three-level retinopathy variable (no retinopathy as referent) and the main independent variables being bouted- and non-bouted MVPA. This model also included the following covariates: *age* (yrs; continuous), *gender*, *race-ethnicity* (Mexican American, non-Hispanic White, non-Hispanic Black, other), self-reported *smoking status* (current, former, never smoker), measured *body mass index* (continuous; kg/m^2), *diabetes status* (yes/no), physician-diagnosed *hypertension* (yes/no), and objectively-measured *visual acuity* [20] (normal vision, uncorrected refractive effort and vision impairment). With regard to diabetes status, participants were defined as having diabetes if they had a physician-diagnosis, had a fasting blood glucose of 126 mg/dL or higher, had an A1C of 6.5% or higher or were taking any diabetes medications. Significance was set at $P < 0.05$.

3. Results

Table 1 displays the weighted characteristics of the sample. As expected, those with worse retinopathy engaged in less MVPA (both bouted and non-bouted), had a higher BMI and were more likely to have diabetes and hypertension.

Table 2 displays the adjusted multinomial regression examining the association between bouted- and non-MVPA on retinopathy. Bouted MVPA was not significantly associated with retinopathy, but for every 1 min/day increase in non-bouted MVPA, participants had a 7% reduced odds of moderate-to-severe retinopathy compared to no retinopathy (OR = 0.93; 95% CI: 0.87–0.99; $P = 0.04$); results were similar in an unadjusted model (OR = 0.93; 95% CI: 0.89–0.97; $P = 0.007$).

4. Discussion

Although a growing body of research highlights the rationale for independent relationships between non-bouted physical activity, lasting <10 min, and favorable health outcomes [4–7], none have investigated the impact of non-bouted (lifestyle) vs. bouted (structured exercise) on retinopathy. The purpose of our study was to investigate the impact of non-bouted (lifestyle) vs. bouted (structured exercise) physical activity on retinopathy prevalence and severity of retinopathy in a representative cohort of Americans. The main finding our study was that individuals who participated in non-bouted physical activity had reduced odds of a retinopathy diagnosis. Specifically, for every 1 min/day increase in non-bouted MVPA, participants had a 7% reduced odds of moderate-to-severe

Table 1
Weighted characteristics of the study variables across retinopathy status ($N = 1501$).

Variable	Point estimate (SE)		
	No retinopathy	Mild retinopathy	Moderate or greater retinopathy
N	1345	131	25
Bouted MVPA, min/day	6.2 (0.4)	6.0 (1.1)	3.7 (1.5)
Non-bouted MVPA, min/day	15.5 (0.3)	17.0 (1.7)	7.9 (1.0)
Age, mean years	55.3 (0.6)	56.1 (1.6)	56.8 (2.0)
Body mass index, mean kg/m^2	28.8 (0.2)	28.6 (0.5)	33.6 (2.4)
Gender, % female	54.7	44.0	36.1
Race-ethnicity, %			
Non-Hispanic white	80.1	73.5	66.8
Current smoker, %			
Diabetic, %	8.5	23.1	82.9
Hypertension, %	36.0	43.1	61.5
Vision impairment, %	0.7	2.1	1.3
Smoker, %	19.3	30.8	9.4

MVPA, moderate-to-vigorous physical activity.

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