Light-Intensity Physical Activity and Life Expectancy: National Health and Nutrition Survey

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Abstract

Introduction. Quantifying the number of years gained (YLG) associated with light-intensity physical activity (LPA) may be important for risk communication in public health. With no studies having examined the role of LPA in life expectancy, this study aims to quantify YLG from LPA in a population-based US sample.

Methods. This study used data from 6,636 participants in the National Health and Nutrition Examination Survey (2003-2006). The analyses were conducted in 2020. LPA was categorized into low, medium, and high based on tertiles, and survival models were applied to estimate YLG from each LPA group. The analyses were repeated in participants with MVPA above or below the median.

Results. During a mean follow-up of 11 years and 55,520 person-years, 994 deaths were recorded. At age 20, participants with low, medium and high LPA had a predicted life expectancy of 55.70 (48.70 – 62.70), 58.96 (52.17 – 65.75) and 60.60 (54.03 – 67.18) years, suggesting significant YLG from medium and high levels of LPA of 3.45 (0.77 – 6.12) and 5.24 (1.88 – 8.60) years. Corresponding YLG at age 45 and 65 was 2.93 (0.40 – 5.47) and 1.98 (0.03 – 3.94) years for the medium LPA group, and 4.53 (1.26 – 7.80) and 3.10 (0.42 – 5.78) years for the high LPA group. This association was significant in participants with below-median MVPA but not for those with above-median MVPA.

Conclusion. LPA may extend life expectancy. Given the low prevalence of MVPA in populations, physical activity promotion efforts may capitalise on emerging evidence on LPA, particularly among the most inactive groups.

Introduction

Levels of moderate-to-vigorous-intensity physical activity (MVPA) are low despite numerous benefits, including reduced risk of premature mortality and increased life expectancy.[1] To date, physical activity guidelines have focused primarily on MVPA. [2] Recent evidence suggests that light-intensity physical activity (LPA), defined as activities of 1.5-3 metabolic equivalents (e.g. slow walking), may also offer health benefits, [5, 6] particularly among people with low levels of MVPA. [7] Evidence on LPA and mortality has been identified as a "major future research need" [2]. Quantifying the number of years gained (YLG) associated with LPA may be important for informing policies and guidelines in public health. This study aims, for the first time, to quantify YLG from LPA in a population-based sample.

Methods

The current prospective analysis used data from the 2003-2004 and 2005-2006 waves of the National Health and Nutrition Examination Survey (NHANES), a stratified, multistage probability sample representative of the civilian non-institutionalized U.S. population. [8] Data were linked to death records from the National Death Index through December 31, 2015. Participants were 18 years or over with at least 1 valid day (> 10 hours of wear time per day) of accelerometry data (n= 8,410), and we reran analysis based on participants with 4+ valid days of data as sensitivity analysis. [3] Considering that those with occult disease were less likely to be active, we left-truncated the sample at 2 years of follow-up (176 deaths). [9] The final analytic sample contained 6,636 participants (Figure 1).

Details regarding accelerometry measures have been fully documented. [3] Briefly, participants wore accelerometers (AM-7164, ActiGraph, LLC, Fort Walton Beach, Florida) on their waist and data reduction followed validated procedures. [3] Using established cut-points,[3, 10] physical activity was classified into LPA (100-760 counts/min) and MVPA (2020+ counts/min). Participants were categorized into LPA tertiles: low (73.05 to 216.57 min/day), medium (216.60 to 276.83 min/day) or high (276.85 to 433.97min/day). Using NHANES sample weights, a flexible parametric survival framework [11] with age as the time scale was used to model the effects of baseline LPA groups on all-cause mortality. Calculation of YLG from LPA involved a two-step process: first, the residual life expectancy for each LPA tertile was estimated as the area under the survival curve (AUC) up to 100 years, conditional on surviving at ages 20 to 100 years old (1-year intervals); then, survival curves were predicted for each individual and averaged them across individuals. Then YLG were calculated as the differences in the average AUC for the LPA medium/high groups, compared with the low-LPA group (reference). [11] Finally, the analyses were repeated in participants with MVPA above or below the median (14 min/day). All models were adjusted for sex, ethnicity, education, smoking status, alcohol intake, body mass index, presence of medical conditions, mobility limitations, family poverty ratio, marital status, and accelerometer measures (MVPA and wear time). Analyses were conducted in 2020 in Stata 15. The alpha was set at 0.05, two-tailed.

Results

On average, participants wore accelerometers for 865 minutes per day, of which 251 minutes were LPA. Those who had low LPA were older and more likely to be male, White, university graduate, not in a married relationship, and have more medical conditions (Table 1).

During a mean follow-up of 11 years and 55,520 person-years (n= 6,636), 994 deaths were recorded. Compared with the low LPA group, participants in the medium and high LPA groups had a lower risk of all-cause mortality (HR [95% CI]: 0.71 [0.58 – 0.86], 0.59 [0.47 – 0.74] respectively). At age 20, participants with low, medium and high LPA had a predicted life expectancy of 55.70 (48.70 – 62.70), 58.96 (52.17 – 65.75) and 60.60 (54.03 – 67.18) years, suggesting significant YLG from medium and high levels of LPA of 3.45 (0.77 – 6.12) and 5.24 (1.88 – 8.60) years. Corresponding YLG at age 45 and 65 was 2.93 (0.40 – 5.47) and 1.98 (0.03 – 3.94) years for the medium LPA group, and 4.53 (1.26 – 7.80) and 3.10 (0.42 – 5.78) years for the high LPA group (Figure 2). Further stratified analysis revealed that the association was significant in those with MVPA at or below-median (< 14 min/day, mean [SD]: 5.75 [4.17]) with YLG of 3.23 (0.54 – 5.92), 3.02 (0.16 – 5.88) and 2.35 (0.08 – 4.63) at an age of 20, 45, and 65 for medium LPA and 4.25 (1.02 – 7.48), 3.99 (0.49 – 7.49) and 3.12 (0.27 – 5.97) for high LPA. However, the YLG was not significantly different from zero for those with above-median MVPA (mean [SD]: 37.44 [21.91]). Results were consistent with those based on four or more valid days of accelerometer data.

Discussion

This is the first study to estimate YLG from accelerometer-derived LPA. Consistent with previous studies, [5, 6] the current findings suggest that LPA could add years to life, particularly among those with low MVPA.

The lack of repeated LPA measures limits our ability to claim causality. Despite left-truncation and statistical adjustment, reverse causation may still be present. Nearly 13% of participants were removed from analyses due to invalid accelerometer data, introducing selection bias. Mortality was low amongst participants aged 40 years or less (~5%). Furthermore, confidence intervals associated with estimated YLG are wide and need to be interpreted with caution. Moreover, accelerometers may not be able to accurately differentiate between sedentary behavior (low energy sitting) and LPA. The definition of LPA in the current study may not differentiate from MVPA (in relative terms) in the elderly and those with low cardiorespiratory fitness. Finally, because there is no established cut-off point for the recommended amount of LPA, we modelled YLG based on data distribution (i.e., tertiles), which limits the public health interpretation of our findings.

A recent meta-analysis based on a small number of studies reported moderately consistent evidence for the protective effects of LPA on cardiometabolic health while indicating an inverse association between LPA and all-cause mortality. [3] Several studies of varied quality[12] have examined associations between LPA and all-cause mortality using NHANES data. [13-15]

These revealed different findings, suggesting that conclusions may be subject to analytical decisions and other methodological issues, such as follow-up periods, left-truncation of data, and whether to include participants with insufficient valid accelerometer data. [9]

From a public health perspective, YLG is a more intuitive metric than others such as HR and may facilitate communication of the benefits of physical activity. [16] Moreover, understanding the effects of health behaviour on YLG is an essential tool in epidemiology, and can be supplemented by the quality of life experienced during those additional years. The modelling strategy in this study (i.e., flexible parametric approach) has demonstrated advantages over more traditional survival methods (e.g., Cox or parametric), including not being influenced by the proportional hazard assumption. [16, 17] The current results and previous evidence [18, 19] suggest that the protective effects of LPA on mortality may be limited to people who accumulate little or no MVPA. [3] The established dose-response effects of physical activity [20] suggest that the greater stimulus of MVPA would be expected to largely override the health effects of low LPA. Nonetheless, increasing LPA remains an important public health strategy.

Conclusions

Compared with MVPA, LPA is mostly incidental in nature without requirements for equipment, facilities, or high levels of fitness, skills or motivation, and therefore, may be more feasible and accessible to the broader population. [5]Encouraging and facilitating LPA through public health programs and environmental and policy interventions could be considered a viable and complementary strategy to promoting MVPA. [21] Promoting LPA may be particularly relevant for people unable to meet the current public health recommendations. [22, 23]

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Figures titles and footnotes

Figure 1. STROBE participant flow diagram

Figure 2. Years of life gained by baseline accelerometer-derived light-intensity physical activity: medium and high vs low (reference). Graph a represents the years of life gained from various levels of LPA in the study sample. Low LPA group (i.e., reference) corresponds to 73.05 to 216.57 min/day of LPA; medium LPA group corresponds to 216.60 to 276.83 min/day; and high LPA group corresponds to 276.83 to 433.97 min/day. The Graphs b and c represent life expectancy associated with LPA for participants with moderate-to-vigorous physical activity (MVPA) at or below the median (14 min/day, b) and above the median (c). All models are adjusted for self-reported sex, ethnicity, education, marital status, poverty ratio, presence of medical conditions, mobility limitations, smoking status, alcohol intake, MVPA and wear time.

Table 1. Baseline characteristics of the study participants (2003-2006, the National Health and Nutrition Examination Survey)

	Total	Low LPA[a]	Medium LPA[a]	High LPA[a]	p-value
	n=6,636	n=2,068	n=2,234	n=2,334	
Deaths, n	994	507	267	220	
Age at baseline, yrs.	50.26 (18.29)	54.10 (20.10)	48.96 (17.85)	48.10 (16.41)	**<0.001**
Body Mass Index (kg/m^2)	28.69 (6.47)	29.13 (7.17)	28.50 (6.19)	28.48 (6.06)	**0.018**
Sex: Female (%)	49.61%	43.33%	49.33%	55.44%	**<0.001**
Unable to walk for a quarter mile (%)	1.07%	1.98%	0.72%	0.60%	**<0.001**
Family income-poverty ratio[b]	2.68 (1.59)	2.72 (1.63)	2.78 (1.60)	2.54 (1.53)	**<0.001**
Race/ ethnicity (%)					**<0.001**
White, non-Hispanic	51.76%	57.69%	53.04%	45.29%	
Black, non-Hispanic	21.38%	21.08%	20.55%	22.45%	
Mexican American	19.85%	14.65%	19.70%	24.59%	
Other Hispanic	2.97%	2.32%	2.91%	3.60%	
Other Race, including Multi-Racial	4.04%	4.26%	3.80%	4.07%	
Education %					**<0.001**
Less than 9th Grade	12.91%	11.56%	12.26%	14.74%	
9-11th grade or less	14.30%	14.12%	13.21%	15.51%	
High school or equivalent	24.53%	20.31%	24.40%	28.41%	
Some college or equivalent	28.60%	27.95%	29.63%	28.19%	
University graduate or above	19.65%	26.06%	20.50%	13.15%	

Marital status %					**<0.001**
Married	55.47%	49.90%	57.16%	58.78%	
Widowed	9.18%	13.01%	7.74%	7.16%	
Divorced	10.28%	10.06%	10.70%	10.07%	
Separated	2.85%	2.47%	2.69%	3.34%	
Never married	15.37%	17.75%	15.31%	13.32%	
Living with partner	6.86%	6.82%	6.40%	7.33%	
Asthma %	12.25%	14.22%	11.15%	11.57%	**0.004**
Arthritis %	27.52%	32.88%	26.14%	24.08%	**<0.001**
Heart Failure %	3.25%	6.00%	2.33%	1.71%	**<0.001**
Angina %	3.60%	5.66%	3.45%	1.93%	**<0.001**
Coronary Heart Disease %	4.45%	7.74%	3.67%	2.27%	**<0.001**
Heart Attack %	4.54%	7.40%	4.12%	2.40%	**<0.001**
Stroke %	3.42%	5.80%	2.69%	2.01%	**<0.001**
Emphysema %	2.02%	3.53%	1.25%	1.41%	**<0.001**
Liver condition %	3.12%	3.63%	3.00%	2.78%	0.300
Cancer %	8.92%	12.19%	8.37%	6.56%	**<0.001**
Current smoking[c] %	35.85%	36.27%	35.32%	35.99%	0.810
Alcohol intake >10 g/day %	25.09%	24.52%	25.34%	25.36%	0.810
Valid wear time, min/day	865.11 (135.04)	825.34 (128.38)	857.24 (119.17)	907.89 (142.73)	**<0.001**
Light-intensity physical activity, min/day	251.36 (71.60)	170.48 (36.26)	247.47 (17.33)	326.74 (40.37)	**<0.001**

Moderate-to-vigorous physical activity, min/day	21.14 (22.20)	17.57 (22.74)	23.39 (23.23)	22.15 (20.25)	**<0.001**

Boldface indicates statistical significance.

Data are presented as mean SD for continuous measures, and % for categorical measures.

[a]LPA, light-intensity physical activity. LPA groups are based on tertiles: low LIPA corresponds to 73.05 to 216.57 min/day; medium LPA corresponds to 216.60 to 276.83 min/day; and high LPA corresponds to 276.85 to 433.97 min/day.

[b]Family income-poverty ratio is calculated by dividing family income by the poverty guidelines, specific to family size, as well as the appropriate year and state.

[c]Current smoking was defined as the serum level of cotinine exceeding >10 ng/mL.