British Journal of
Sports Medicine

The "Weekend Warrior" physical activity pattern: how little is enough?

Journal:	*British Journal of Sports Medicine*
Manuscript ID	bjsports-2017-097538.R1
Article Type:	Editorial
Date Submitted by the Author:	n/a
Complete List of Authors:	Hamer, Mark; Loughborough University, School of Sport Exercise and Health Sciences; University College London, O'Donovan, Gary; Loughborough University Lee, I-Min; Harvard Medical School, Stamatakis, Emmanuel; UCL, Epidemiology and Public Health; University of Sydney , Exercise and Sport Sciences
Keywords:	Physical activity, Exercise, Death, Epidemiology, Public health

The "Weekend Warrior" physical activity pattern: how little is enough?

Mark Hamer,[1] Gary O'Donovan,[1] I-Min Lee,[2] Emmanuel Stamatakis[3]

[1] School Sport, Exercise & Health Sciences, National Centre for Sport & Exercise Medicine, Loughborough University, Loughborough, United Kingdom.

[2]Harvard University, Harvard Medical School, Brigham and Women's Hospital, Boston MA 02215, United States of America.

[3]Charles Perkins Centre, Prevention Research Collaboration, School of Public Health, University of Sydney, Sydney, Australia.

Corresponding author: Emmanuel Stamatakis: Charles Perkins Centre, Prevention Research Collaboration, School of Public Health, University of Sydney, Sydney, Australia.

+61 432704690

word count = 858

MANUSCRIPT

The dose-response relationship between physical activity and health is of great interest to policy-makers, clinicians and individuals. Several recent analyses of large scale population data have advanced our understanding, particularly in teasing apart *minimal* and *optimal* physical activity dosage. For example, if we focus on 'minimal' dose, 15 min a day of moderate-intensity exercise lowered mortality in a sample of more than 400,000 adults from Taiwan.[1] A recent meta-analysis of 9 cohort studies revealed that undertaking some moderate to vigorous physical activity (MVPA) but less than the guidelines was associated with 22% reduction in mortality risk in older adults.[2] For those fortunate to be able to be performing the 'optimal' levels of physical activity, an analysis of over 600,000 adults of all ages from the US and Europe, showed that a nearly optimal threshold for longevity occurred at 3 to 5 times the physical activity recommendation (39% reduction in all-cause mortality). Note that the additional benefit over and above doses corresponding to 1-2 multiples of the physical activity guideline (31% reduction in all-cause mortality) was rather modest in general.[3]

The "weekend warrior" physical activity pattern – good for health!

In a new study[4] using a large sample of British adults we aimed to explore the importance of physical activity frequency, in particular the "weekend warrior" exercise pattern where people meet the MVPA recommendations in just 1-2 sessions per week, originally described by Lee and colleagues[5]. We found that the weekend warriors and those regularly active (≥3 sessions per week reporting ≥150 min/wk in moderate-intensity or ≥75 min/wk in vigorous-intensity activities) had similar reduction in risk of all-cause, cardiovascular and cancer mortality[4]. These finding raised a number of key discussion areas.

Minimal dosage for health benefit

From a public health perspective the greatest gains can be achieved from the transition of large numbers of people from inactivity to some activity[3 4], which has partly motivated interest in identifying the *minimal* dosage for health benefit[1]. In our study we also identified "insufficiently active weekend warriors" who reported 1-2 sessions per week of MVPA but did not meet the physical activity guidelines. Compared with the inactive participants, there was a 17 – 34% reduction in risk (depending on outcome) in the "insufficiently active" participants who reported 1 or 2 MVPA sessions per week.[4] We conducted further analyses to better understand the characteristics of this group. Insufficiently active weekend warriors reported almost an hour less total physical activity volume of any intensity (258 vs 315 min/wk, $p<0.001$), had a larger deficit in MVPA volume (44 vs. 91 min/wk, $p<0.001$), higher sports participation (86 vs. 63%, $p=0.01$) compared with their regularly active counterparts. Worth noting that there were also some minor differences in vigorous physical activity between the two groups that were statistically significant but highly unlikely to be of clinical importance (12 vs 10 min/wk, $p<0.001$). We further explored dose response patterns in the "insufficiently active" participants (**Table 1**). There was no evidence of a dose response pattern between total MVPA volume (in the 1-149 min/wk range) and mortality (p-trend = 0.24), although there was a linear trend ($p<0.001$) when analysing total physical activity. This may suggest that some of the health benefits observed in the insufficiently active participants are explained by non-exercise activity, such as light intensity walking.

Mechanisms

Despite our recent encouraging findings[4] for weekend warriors, there are good reasons to think that a more regular physical activity pattern (i.,e active on most days of the week) might reap greater health benefits, as every sustained bout of aerobic exercise has acute physiological effects that may last for up to 24 hours.[6] We therefore conducted further analysis to explore the physiology of the weekend warrior (see **Table 2**).

In cross-sectional analyses we observed a clear dose-response association between a range of traditional risk factors (high density lipoprotein cholesterol, glycated haemoglobin, fibrinogen, C-reactive protein, body mass index, systolic blood pressure, and cardiorespiratory fitness) and MVPA. The most favourable profile was consistently observed in "regularly active" participants (those meeting physical activity guidelines through >2 sessions per week); the weekend warrior participants demonstrated intermediate levels of risk factors.

Interestingly, when we calculated cardiorespiratory fitness using a non-exercise testing method,[7] only relatively small differences (B= 1.00, 95% CI, 0.73, 1.27 ml/kg/min) were observed between weekend warrior and regularly active participants despite using a computational method that favours the regularly active by accounting only for MVPA frequency and not volume. The weekend warriors in our study undertook a large proportion of vigorous-intensity exercise (e.g. 94% participated in vigorous sports)[4], suggesting that physical activity quality (intensity) may be more important than quantity. Vigorous-intensity

exercise improves aerobic fitness more than the same amount of moderate-intensity exercise, and two bouts of vigorous-intensity exercise a week are enough to maintain aerobic fitness.

Take home message

In conclusion, teasing apart the dose response relationship between physical activity and health will help refine our public health guidelines and in doing so facilitate an "exercise is medicine" approach for prescribing physical activity. Our data suggest that "more than one road leads to Rome" in terms of physical activity frequency and mortality benefits, although there are perhaps still good reasons to strive for daily or nearly-daily physical activity (including lower risk of musculoskeletal injury).

ACKNOWLEDGEMENTS & FUNDING

We would like to thank the participants of the Health Survey for England and the Scottish Health Survey for making this additional analysis as well as the original study (O'Donovan G, et al. JAMA Intern Med. Published online 9/1/2017, doi:10.1001/jamainternmed.2016.8014) possible. There was no specific funding for this paper. ES is funded by the National Health and Medical Research Council through a Senior Research Fellowship. The dataset acquisition and harmonization was funded by a National Institute for Health Research (UK) grant to ES. The views expressed here are those of the authors and not necessarily the funders.

COMPETING INTERESTS

None.

COPYRIGHT

LICENCE

REFERENCES

1. Wen CP, Wai JP, Tsai MK, Yang YC, Cheng TY, Lee MC, Chan HT, Tsao CK, Tsai SP, Wu X. Minimum amount of physical activity for reduced mortality and extended life expectancy: a prospective cohort study. Lancet. 2011;378(9798):1244-53.
2. Hupin D, Roche F, Gremeaux V, Chatard JC, Oriol M, Gaspoz JM, Barthélémy JC, Edouard P. Even a low-dose of moderate-to-vigorous physical activity reduces mortality by 22% in adults aged ≥60 years: a systematic review and meta-analysis. Br J Sports Med. 2015 Oct;49(19):1262-7.
3. Arem H, Moore SC, Patel A, Hartge P, Berrington de Gonzalez A, Visvanathan K, Campbell PT, Freedman M, Weiderpass E, Adami HO, Linet MS, Lee IM, Matthews CE. Leisure time physical activity and mortality: a detailed pooled analysis of the dose-response relationship. JAMA Intern Med. 2015;175(6):959-67.
4. O'Donovan G, Lee I-Min, Hamer M, Stamatakis E. The 'weekend warrior' and other leisure-time physical activity patterns and the risks of all-cause, cardiovascular disease, and cancer mortality. JAMA Intern Med. Published online January 9, 2017. doi:10.1001/jamainternmed.2016.8014
5. Lee IM, Sesso HD, Oguma Y, Paffenbarger RS Jr. The "weekend warrior" and risk of mortality. Am J Epidemiol. 2004;160(7):636-641.
6. Gill JM, Al-Mamari A, Ferrell WR, Cleland SJ, Packard CJ, Sattar N, Petrie JR, Caslake MJ. Effects of prior moderate exercise on postprandial metabolism and

vascular function in lean and centrally obese men. J Am Coll Cardiol. 2004;44(12):2375-82.

7. Stamatakis E, Hamer M, O'Donovan G, Batty GD, Kivimaki M. A non-exercise testing method for estimating cardiorespiratory fitness: associations with all-cause and cardiovascular mortality in a pooled analysis of eight population-based cohorts. Eur Heart J. 2013;34(10):750-8.

Table 1. Cox proportional hazard ratios (HR) for dose response patterns between physical activity and mortality in "insufficiently active" adults.

Physical activity	Deaths/N (Total: 884/12420)	All-cause mortality HR† (95% CI)
MVPA quartile		
>1 – 22min/wk	221/2872	1.0 (Reference)
>22 – 45 min/wk	199/2734	0.94 (0.78, 1.15)
>45 – 75 min/wk	229/3393	0.95 (0.79, 1.15)
>75 < 150 min/wk	235/3421	0.92 (0.76, 1.10)
Any PA quartile		
>1 < 73min/wk	265/3093	1.0 (Reference)
73 – 150 min/wk	209/2994	0.89 (0.74, 1.06)
>150 – 322 min/wk	222/3222	0.83 (0.69, 0.99)
>322 min/wk	182/3012	0.71 (0.59, 0.86)

†Models adjusted for age, sex, smoking, occupational social class, and longstanding illness.

Participants who died during the first 24 months of follow-up were excluded.

Table 2. The weekend warrior exercise pattern and biomedical risk factors.

	Inactive	Insufficiently active	Weekend warrior	Regularly active
NETCRF (ml/kg/min)	33.6±0.04	35.1±0.06†	36.0±0.12†	37.0±0.07†‡
Resting pulse (bpm)	71.0±0.08	69.6±0.13†	68.5±0.27†	68.0±0.15†
HDL-C (mmol/l)	1.47 ± 0.003	1.51 ± 0.01†	1.55 ± 0.01†	1.57 ± 0.01†‡
HbA1C (%)	5.97 ± 0.01	5.84 ± 0.02†	5.79 ± 0.03†	5.63 ± 0.02†‡
Fibrinogen (g/L)	3.18 ± 0.01	3.05 ± 0.01†	3.02 ± 0.02†	2.98 ± 0.01†‡
C-reactive Proteinł	1.25 ± 0.01	1.11 ± 0.01†	1.09 ± 0.02†	1.03 ± 0.01†‡

BMI (Kg/m^2)	27.8±0.03	27.2±0.04†	27.1±0.08†	26.5±0.06†‡
WHR	0.89±0.001	0.88±0.001†	0.87±0.001†	0.87±0.001†
Systolic BP (mmHg)	137.8±0.12	136.3±0.20†	135.7±0.41†	134.4±0.25†‡

Sample sizes for each biomedical variable range from n= 22,868 to n=43,552.

Data presented as mean (SE) adjusted for age, sex, smoking, occupation, and longstanding illness.

†p<0.05 in comparison to "inactive"; ‡ p<0.05 when "regularly active" compared to all other groups

ł C-reactive protein was log transformed to normalise the distribution.

(NETCRF) Non-exercise testing cardiorespiratory fitness (calculated using age, sex, body mass index, resting pulse)[8]; (HDL-C) High density lipoprotein cholesterol; (HbA1C) glycated haemoglobin; (BMI) body mass index; (WHR) Waist-to-hip ratio; (BP) blood pressure