
Title

Device-measured sedentary time and intensity-specific physical activity in relation to all-cause and cardiovascular disease mortality: the UK Biobank cohort study

Abstract

Background and aims: Understanding the amounts of intensity-specific movement needed to attenuate the association between sedentary time and mortality may help to inform personalized prescription and behavioral counselling. Herein, we examined the joint associations of sedentary time and intensity-specific physical activity with all-cause and cardiovascular disease (CVD) mortality. Methods: Prospective cohort study including 73,729 adults from the UK Biobank who wore an Axivity AX3 accelerometer on their dominant wrist for at least 3 days, being one a weekend day, between June 2013 and December 2015. We considered the median tertile values of sedentary time and physical activity in each intensity band to determine the amount of physical activity needed to attenuate the association between sedentary time and mortality. Results: During a median of 6.9 years of follow-up (628,807 person-years), we documented 1521 deaths, including 388 from CVD. Physical activity of any intensity attenuated the detrimental association of sedentary time with mortality. Overall, at least a median of 6 min/day of vigorous physical activity, 30 min/day of MVPA, 64 min/day of moderate physical activity, or 163 min/day of light physical activity (mutually-adjusted for other intensities) attenuated the association between sedentary time and mortality. High sedentary time was associated with higher risk of CVD mortality only among participants with low MVPA (HR 1.96; 95% CI 1.23 to 3.14). Conclusions: Different amounts of each physical activity intensity may attenuate the association between high sedentary time and mortality. © The Author(s) 2024.

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References

Bull F.C., Al-Ansari S.S., Biddle S., Borodulin K., Buman M.P., Cardon G., Et al., World Health Organization 2020 guidelines on physical activity and sedentary behaviour, *Br J Sports Med*, 54, pp. 1451-1462, (2020); Ekelund U., Steene-Johannessen J., Brown W.J., Fagerland M.W., Owen N., Powell K.E., Et al., Does physical activity attenuate, or even eliminate, the detrimental association of sitting time with mortality? A harmonised meta-analysis of data from more than 1 million men and women, *Lancet*, 388, pp. 1302-1310, (2016); Stamatakis E., Gale J., Bauman A., Ekelund U., Hamer M., Ding D., Sitting time, physical activity, and risk of mortality in adults, *J Am Coll Cardiol*, 73, pp. 2062-2072, (2019); Ekelund U., Brown W.J., Steene-Johannessen J., Fagerland M.W., Owen N., Powell K.E., Et al., Do the associations of sedentary behaviour with cardiovascular disease mortality and cancer mortality differ by physical activity level? A systematic review and harmonised meta-analysis of data from 850 060 participants, *Br J Sports Med*, 53, pp. 886-894, (2019); Stamatakis E., Ahmadi M.N., Gill J.M.R., Thogersen-Ntoumani

C., Gibala M.J., Doherty A., Et al., Association of wearable device-measured vigorous intermittent lifestyle physical activity with mortality, *Nat Med*, 28, pp. 2521-2529, (2022); Ahmadi M.N., Clare P.J., Katzmarzyk P.T., Del Pozo Cruz B., Lee I.M., Stamatakis E., Vigorous physical activity, incident heart disease, and cancer: how little is enough?, *Eur Heart J*, 43, pp. 4801-4814, (2022); Lee D.H., Rezende L.F.M., Joh H.K., Keum N., Ferrari G., Rey-Lopez J.P., Et al., Long-term leisure-time physical activity intensity and all-cause and cause-specific mortality: a prospective cohort of US adults, *Circulation*, 146, pp. 523-534, (2022); Strain T., Wijndaele K., Dempsey P.C., Sharp S.J., Pearce M., Jeon J., Et al., Wearable-device-measured physical activity and future health risk, *Nat Med*, 26, pp. 1385-1391, (2020); Del Pozo-Cruz J., Garcia-Hermoso A., Alfonso-Rosa R.M., Alvarez-Barbosa F., Owen N., Chastin S., Et al., Replacing Sedentary Time: Meta-analysis of Objective-Assessment studies, *Am J Prev Med*, 55, pp. 395-402, (2018); Ekelund U., Tarp J., Steene-Johannessen J., Hansen B.H., Jefferis B., Fagerland M.W., Et al., Dose-response associations between accelerometry measured physical activity and sedentary time and all cause mortality: systematic review and harmonised meta-analysis, *BMJ*, 366, (2019); Ku P.W., Steptoe A., Liao Y., Hsueh M.C., Chen L.J., A cut-off of daily sedentary time and all-cause mortality in adults: a meta-regression analysis involving more than 1 million participants, *BMC Med*, 16, (2018); Ku P.W., Steptoe A., Liao Y., Hsueh M.C., Chen L.J., A threshold of objectively-assessed Daily Sedentary Time for all-cause mortality in older adults: a Meta-regression of prospective cohort studies, *J Clin Med*, 8, (2019); Manas A., Del Pozo-Cruz B., Garcia-Garcia F.J., Guadalupe-Grau A., Ara I., Role of objectively measured sedentary behaviour in physical performance, frailty and mortality among older adults: a short systematic review, *Eur J Sport Sci*, 17, pp. 940-953, (2017); Patterson R., McNamara E., Tainio M., de Sa T.H., Smith A.D., Sharp S.J., Et al., Sedentary behaviour and risk of all-cause, cardiovascular and cancer mortality, and incident type 2 diabetes: a systematic review and dose response meta-analysis, *Eur J Epidemiol*, 33, pp. 811-829, (2018); Xu C.,

Furuya-Kanamori L., Liu Y., Faerch K., Aadahl M., Sedentary behavior, physical activity, and all-cause mortality: dose-response and intensity Weighted Time-Use Meta-analysis, *J Am Med Dir Assoc*, 20, pp. 1206-1123, (2019); Bailey D.P., Hewson D.J., Champion R.B., Sayegh S.M., Sitting time and risk of Cardiovascular Disease and Diabetes: a systematic review and Meta-analysis, *Am J Prev Med*, 57, pp. 408-416, (2019); Ahmad S., Shanmugasegaram S., Walker K.L., Prince S.A., Examining sedentary time as a risk factor for cardiometabolic diseases and their markers in south Asian adults: a systematic review, *Int J Public Health*, 62, pp. 503-515, (2017); DiPietro L., Al-Ansari S.S., Biddle S.J.H., Borodulin K., Bull F.C., Buman M.P., Et al., Advancing the global physical activity agenda: recommendations for future research by the 2020 WHO physical activity and sedentary behavior guidelines development group, *Int J Behav Nutr Phys Act*, 17, (2020); Blodgett J.M., Ahmadi M.N., Atkin A.J., Chastin S., Chan H.W., Suorsa K., Et al., Device-measured physical activity and cardiometabolic health: the prospective physical activity, sitting, and Sleep (ProPASS) consortium, *Eur Heart J*, 45, pp. 458-471, (2024); Walmsley R., Chan S., Smith-Byrne K., Ramakrishnan R., Woodward M., Rahimi K., Et al., Reallocation of time between device-measured movement behaviours and risk of incident cardiovascular disease, *Br J Sports Med*, 56, pp. 1008-1017, (2021); Ekelund U., Tarp J., Fagerland M.W., Johannessen J.S., Hansen B.H., Jefferis B.J., Et al., Joint associations of accelerometer measured physical activity and sedentary time with all-cause mortality: a harmonised meta-analysis in more than 44 000 middle-aged and older individuals, *Br J Sports Med*, 54, pp. 1499-1506, (2020); Lee D.H., Rezende L.F.M., Ferrari G., Aune D., Keum N., Tabung F.K., Et al., Physical activity and all-cause and cause-specific mortality: assessing the impact of reverse causation and measurement error in two large prospective cohorts, *Eur J Epidemiol*, 36, pp. 275-285, (2021); Rezende L.F.M., Lee D.H., Ferrari G., Giovannucci E., Confounding due to pre-existing diseases in epidemiologic studies on sedentary behavior and all-cause mortality: a meta-epidemiologic study, *Ann Epidemiol*, 52,

pp. 7-14, (2020); Wang Y., Nie J., Ferrari G., Rey-Lopez J.P., Rezende L.F.M., Association of Physical Activity Intensity with Mortality: A National Cohort Study of 403681 US adults, *JAMA Intern Med*, 2020; Ahmadi M.N., Nathan N., Sutherland R., Wolfenden L., Trost S.G., Non-wear or sleep? Evaluation of five non-wear detection algorithms for raw accelerometer data, *J Sports Sci*, 38, pp. 399-404, (2020); Sipos M.P.P., Rohac J., Novacek P., Analyses of Triaxial Accelerometer Calibration algorithms, *IEEE Sens J*, 12, 5, pp. 1157-1165, (2011); Pavey T.G., Gilson N.D., Gomersall S.R., Clark B., Trost S.G., Field evaluation of a random forest activity classifier for wrist-worn accelerometer data, *J Sci Med Sport*, 20, pp. 75-80, (2017); Del Pozo Cruz B., Ahmadi M.N., Lee I.M., Stamatakis E., Prospective associations of Daily Step counts and Intensity with Cancer and Cardiovascular Disease incidence and mortality and all-cause mortality, *JAMA Intern Med*, 182, pp. 1139-1148, (2022); Del Pozo Cruz B., Ahmadi M., Naismith S.L., Stamatakis E., Association of Daily Step Count and Intensity With Incident Dementia in 78 430 adults living in the UK, *JAMA Neurol*, 79, pp. 1059-1063, (2022); Ding D., Van Buskirk J., Nguyen B., Stamatakis E., Elbarbary M., Veronese N., Et al., Physical activity, diet quality and all-cause cardiovascular disease and cancer mortality: a prospective study of 346 627 UK Biobank participants, *Br J Sports Med*, (2022); Rutten-Jacobs L.C., Larsson S.C., Malik R., Rannikmae K., consortium M., Genetics I.S., Genetic risk, incident stroke, and the benefits of adhering to a healthy lifestyle: cohort study of 306 473 UK Biobank participants, *BMJ*, 363, (2018); Hildebrand M., Vt V., Hansen B.H., Ekelund U., Age group comparability of raw accelerometer output from wrist- and hip-worn monitors, *Med Sci Sports Exerc*, 46, pp. 1816-1824, (2014); Rezende L.F.M., Sa T.H., Mielke G.I., Viscondi J.Y.K., Rey-Lopez J.P., Garcia L.M.T., All-cause Mortality attributable to sitting time: analysis of 54 Countries Worldwide, *Am J Prev Med*, 51, pp. 253-263, (2016); VanderWeele T.J., Principles of confounder selection, *Eur J Epidemiol*, 34, pp. 211-219, (2019); Stamatakis E., Owen K.B., Shepherd L., Drayton B., Hamer M., Bauman A.E., Is Cohort Representativeness Passé? Poststratified associations of

Lifestyle Risk factors with mortality in the UK Biobank, *Epidemiology*, 32, pp. 179-188, (2021)

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