$$P = \frac{\Delta W}{\Delta t} = \frac{\Delta E}{\Delta t}$$

MET verstehen-
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Bielefeld 06. April 2019
Dr. Meinolf Behrens

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Studien verstehen

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EXERCISE CAPACITY AND MORTALITY AMONG MEN REFERRED FOR EXERCISE TESTING

JONATHAN MYERS, PH.D., MANISH PRAKASH, M.D., VICTOR FROELICHER, M.D., DAT DO, M.D., SARA PARTINGTON, B.SC., AND J. EDWIN ATWOOD, M.D.

ABSTRACT

Background Exercise capacity is known to be an important prognostic factor in patients with cardiovascular disease, but it is uncertain whether it predicts mortality equally well among healthy persons. There is also uncertainty regarding the predictive power of exercise capacity relative to other clinical and exercise-test variables.

Methods We studied a total of 6213 consecutive men referred for treadmill exercise testing for clinical reasons during a mean (±SD) of 6.2±3.7 years of follow-up. Subjects were classified into two groups: 3679 had an abnormal exercise-test result or a history of cardiovascular disease, or both, and 2534 had a normal exercise-test result and no history of cardiovascular disease. Overall mortality was the end point.

Results There were a total of 1256 deaths during the follow-up period, resulting in an average annual mortality of 2.6 percent. Men who died were older than those who survived and had a lower maximal heart rate, lower maximal systolic and diastolic blood pressure, and lower exercise capacity. After adjustment for age, the peak exercise capacity measured in metabolic equivalents (MET) was the strongest predictor of the risk of death among both normal subjects and those with cardiovascular disease. Absolute peak exercise capacity was a stronger predictor of the risk of death than the percentage of the age-predicted value achieved, and there was no interaction between the use or nonuse of beta-blockade and the predictive power of exercise capacity. Each 1-MET increase in exercise capacity conferred a 12 percent improvement in survival.

Conclusions Exercise capacity is a more powerful predictor of mortality among men than other established risk factors for cardiovascular disease. (N Engl J Med 2002;346:793-801.)

DURING the past two decades, exercise capacity and activity status have become well-established predictors of cardiovascular and overall mortality.[1,2] The fact that exercise capacity is a strong and independent predictor of outcomes supports the value of the exercise test as a clinical tool; it is noninvasive, is relatively inexpensive, and provides a wealth of clinically relevant diagnostic and prognostic information.[3,4] However, recent guidelines[4] and commentaries on the topic[5,6] have identified several areas related to the prognostic usefulness of exercise testing that are in need of further study. For example, the majority of previous studies have not clearly assessed the independent prognostic power of exercise capacity relative to other clinical variables and information from exercise testing. In addition, whereas the literature is filled with long-term follow-up studies conducted in relatively healthy populations,[7-11] few studies have focused on more clinically relevant populations — that is, patients referred for exercise testing for clinical reasons. Moreover, although exercise capacity expressed in terms of metabolic equivalents (MET) is the common clinical measure of exercise tolerance, exercise capacity is strongly influenced by age and activity status. It is not known which has greater prognostic value: the absolute peak exercise capacity (measured in MET) or exercise capacity expressed as a percentage of the value predicted on the basis of age. Finally, the use of beta-blocker therapy is common among the patients who are typically referred for exercise testing; although beta-blockade improves survival, it can also reduce exercise capacity. Data related to the influence of beta-blockade on the prognostic value of exercise tolerance are sparse.

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Myers J, Prakash M, Froelicher V et al (2002) Exercise capacity and mortality among men referred for exercise testing. N Engl J Med 346:793–801

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Clinical Care/Education/Nutrition
ORIGINAL ARTICLE

Make Your Diabetic Patients Walk

Long-term impact of different amounts of physical activity on type 2 diabetes

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OBJECTIVE — To establish the impact of different amounts of increased energy expenditure on type 2 diabetes care.

RESEARCH DESIGN AND METHODS — Post hoc analysis of long-term effects of different amounts of increased energy expenditure (metabolic equivalents [METS] per hour per week) through voluntary aerobic physical activity was performed in 179 type 2 diabetic subjects (age 62 ± 1 years [mean ± SE]) randomized to a physical activity counseling intervention. Subjects were followed for 2 years and divided into six groups based on their increments in METs per hour per week: group 0 (no activity, $n = 28$), group 1–10 (6.8 ± 0.3, $n = 27$), group 11–20 (17.1 ± 0.4, $n = 31$), group 21–30 (27.0 ± 0.5, $n = 27$), group 31–40 (37.5 ± 0.5, $n = 32$), and group >40 (58.3 ± 1.8, $n = 34$).

RESULTS — At baseline, the six groups did not differ for energy expenditure, age, sex, diabetes duration, and all parameters measured. After 2 years, in group 0 and in group 1–10, no parameter changed; in groups 11–20, 21–30, 31–40, and >40, HbA_{1c}, blood pressure, total serum cholesterol, triglycerides, and estimated percent of 10-year coronary heart disease risk improved ($P < 0.05$). In group 21–30, 31–40, and >40, body weight, waist circumference, heart rate, fasting plasma glucose, serum LDL and HDL cholesterol also improved ($P < 0.05$). METs per hour per week correlated positively with changes of HDL cholesterol and negatively with those of other parameters ($P < 0.001$). After 2 years, per capita yearly costs of medications increased ($P = 0.008$) by $393 in group 0, did not significantly change in group 1–10 ($206, $P = 0.09$), and decreased in group 11–20 (−$196, $P = 0.01$), group 21–30 (−$593, $P = 0.009$), group 31–40 (−$660, $P = 0.003$), and group >40 (−$579, $P = 0.001$).

CONCLUSIONS — Energy expenditure >10 $METs \cdot h^{-1} \cdot week^{-1}$ obtained through aerobic leisure time physical activity is sufficient to achieve health and financial advantages, but full benefits are achieved with energy expenditure >20 $METs \cdot h^{-1} \cdot week^{-1}$.

Diabetes Care 28:1295–1302, 2005

Western and developing countries face two serious health problems: the rising prevalence of obesity and diabetes and the fact that people no longer need to be physically active in their daily lives (1–4). Many studies have shown that regular physical activity improves quality of life, reduces the risk of mortality from all causes (1–4), and is particularly advantageous in subjects with impaired glucose tolerance (5,6) or type 2 diabetes (7–12). Physical activity counseling can motivate most diabetic subjects to increase their levels of voluntary energy expenditure (9–11), but, at present, the relationship between amounts of physical activity and long-term beneficial effects in type 2 diabetes care is unknown. The American Diabetes Association emphasizes the benefits of regular physical activity in the prevention and treatment of type 2 diabetes, referring to proposals given to the general population by several scientific societies (1–4,12). These recommendations advise individuals to engage in ≥30 min moderate-intensity physical activity on most (preferably all) days of the week. To maintain long-term weight loss, data from several studies suggest that more exercise (60–75 min/day) is needed (1,12,13).

As no long-term studies have been performed in type 2 diabetic subjects, the influence of different amounts of energy expenditure on diabetes care remains to be established. This study examines the 2-year impact of different increments in energy expenditure on several physiological and biochemical outcomes, on direct medical costs, and on direct and indirect social costs in a group of type 2 diabetic subjects who were randomized to an exercise counseling intervention (9). Our data show that 2 years' counseling resulted in remarkable cost saving; health benefits and financial advantages were significantly related with increased amounts of energy expenditure.

RESEARCH DESIGN AND METHODS — Eligibility criteria included diagnosis of type 2 diabetes of at

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Abbreviations: CHD, coronary heart disease; FPG, fasting plasma glucose; MET, metabolic equivalent; NHS, National Health Service.

A table elsewhere in this issue shows conventional and Système International (SI) units and conversion factors for many substances.

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See accompanying editorial, p. 1524.

DiLoreto et al: Make Your Diabetic Patients Walk
Diabetes care (2005) 28: 1295-1302

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Articles

Minimum amount of physical activity for reduced mortality and extended life expectancy: a prospective cohort study

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Lancet 2011; 378: 1244–53

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See Comment page 1202

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Summary

Background The health benefits of leisure-time physical activity are well known, but whether less exercise than the recommended 150 min a week can have life expectancy benefits is unclear. We assessed the health benefits of a range of volumes of physical activity in a Taiwanese population.

Methods In this prospective cohort study, 416 175 individuals (199 265 men and 216 910 women) participated in a standard medical screening programme in Taiwan between 1996 and 2008, with an average follow-up of 8·05 years (SD 4·21). On the basis of the amount of weekly exercise indicated in a self-administered questionnaire, participants were placed into one of five categories of exercise volumes: inactive, or low, medium, high, or very high activity. We calculated hazard ratios (HR) for mortality risks for every group compared with the inactive group, and calculated life expectancy for every group.

Findings Compared with individuals in the inactive group, those in the low-volume activity group, who exercised for an average of 92 min per week (95% CI 71–112) or 15 min a day (SD 1·8), had a 14% reduced risk of all-cause mortality (0·86, 0·81–0·91), and had a 3 year longer life expectancy. Every additional 15 min of daily exercise beyond the minimum amount of 15 min a day further reduced all-cause mortality by 4% (95% CI 2·5–7·0) and all-cancer mortality by 1% (0·3–4·5). These benefits were applicable to all age groups and both sexes, and to those with cardiovascular disease risks. Individuals who were inactive had a 17% (HR 1·17, 95% CI 1·10–1·24) increased risk of mortality compared with individuals in the low-volume group.

Interpretation 15 min a day or 90 min a week of moderate-intensity exercise might be of benefit, even for individuals at risk of cardiovascular disease.

Funding Taiwan Department of Health Clinical Trial and Research Center of Excellence and National Health Research Institutes.

Introduction

Much evidence suggests that 150 min or more a week of leisure-time physical activity (LTPA) can have substantial health benefits for an individual.[1,2] Guidelines such as the 2008 physical activity guidelines for Americans[1] and WHO's 2010 Global Recommendations on Physical Activity for Health[2,3] have drawn attention to the health benefits of this amount of weekly exercise. Because barriers exist to meet this 30 min a day, 5 day a week recommendation (eg, time constraints or an individual's uncertainty about the amount of exercise needed to benefit health), LTPA is an underused public health intervention. East Asians tend to be less physically active than individuals in western countries, and also tend to exercise at lower intensity.[4,5] A third of the American adult population met this recommendation,[1] whereas less than a fifth of the adult population did in East Asian countries such as China, Japan, or Taiwan.[4,5] Whether levels of physical activity below the recommended 150 min a week are adequate to generate health benefits is unclear.

Identification of a minimum amount of exercise—or minimum dose[6]—sufficient to reduce mortality is desirable because a small amount of exercise can be easier to achieve. Furthermore, patients might be more easily motivated to exercise if their doctor recommends an easily manageable amount, especially if health messages are simple. Because east Asians visit their doctors frequently,[8] plenty of opportunities for health communication and prescription of exercise exist.[7] However, such opportunities to prescribe exercise are sometimes missed because most doctors are expected to treat only diseases, having little time to modify a behaviour that is not directly related to the disease if not requested by a patient. If health-enhancing physical activity were to be prescribed, it should be related to the disease in question, and the recommended amount should be kept to a minimum to increase the chances of adherence.

The objective of this study is to assess the health benefits of different volumes of physical activity in a large cohort in Taiwan, and to investigate whether less than 150 min a week of exercise is sufficient to reduce mortality or extend life expectancy.

Methods

Data collection

In this historically prospective cohort study, the cohort consisted of 416 175 healthy individuals aged 20 years or older (199 265 men and 216 910 women) who participated

Wen et al.: Minimum amount of physical activity for reduced mortality and extended life expectancy: A prospective cohort study. Lancet 2011; 378: 1244–53

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REVIEW ARTICLE

Physical Activity and Mortality in Individuals With Diabetes Mellitus

A Prospective Study and Meta-analysis

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Background: Physical activity (PA) is considered a cornerstone of diabetes mellitus management to prevent complications, but conclusive evidence is lacking.

Methods: This prospective cohort study and meta-analysis of existing studies investigated the association between PA and mortality in individuals with diabetes. In the EPIC study (European Prospective Investigation Into Cancer and Nutrition), a cohort was defined of 5859 individuals with diabetes at baseline. Associations of leisure-time and total PA and walking with cardiovascular disease (CVD) and total mortality were studied using multivariable Cox proportional hazards regression models. Fixed- and random-effects meta-analyses of prospective studies published up to December 2010 were pooled with inverse variance weighting.

Results: In the prospective analysis, total PA was associated with lower risk of CVD and total mortality. Compared with physically inactive persons, the lowest mortality risk was observed in moderately active persons: hazard ratios were 0.62 (95% CI, 0.49-0.78) for total mortality and 0.51 (95% CI, 0.32-0.81) for CVD mortality. Leisure-time PA was associated with lower total mortality risk, and walking was associated with lower CVD mortality risk. In the meta-analysis, the pooled random-effects hazard ratio from 5 studies for high vs low total PA and all-cause mortality was 0.60 (95% CI, 0.49-0.73).

Conclusions: Higher levels of PA were associated with lower mortality risk in individuals with diabetes. Even those undertaking moderate amounts of activity were at appreciably lower risk for early death compared with inactive persons. These findings provide empirical evidence supporting the widely shared view that persons with diabetes should engage in regular PA.

Arch Intern Med. 2012;172(17):1285-1295.
Published online August 6, 2012.
doi:10.1001/archinternmed.2012.3130

Diabetes mellitus is a major cause of illness and premature death in most countries.[1] Efforts to reduce the impact of diabetes complications have been predominantly aimed at controlling hyperglycemia, hypertension, and dyslipidemia by using medication strategies, despite the lack of evidence of long-term benefits.[2,3] However, diabetes management should extend to an overall intervention strategy that includes lifestyle modification to reduce the risk of complications.[4]

See also pages 1283 and 1306

Lifestyle measures, including physical activity (PA), are key factors for self-management in patients with diabetes to prevent macrovascular complications and premature mortality.[5] Increased PA has long been considered a cornerstone of diabetes management. Persons with diabetes are recommended to engage in at least 150 minutes per week of moderate-intensity aerobic PA.[3-6] Walking has been of particular interest because it requires no specific facilities, can be easily implemented in the daily routine, and is relatively safe.[7]

In the general population, being physically active has been associated with a lower risk of overall and cardiovascular disease (CVD) mortality compared with being

Author Affiliations are listed at the end of this article.

Sluik etal: Physical Activity an Moratlity in Individuals With Diabetes Mellitus. A Prospektive Study an Meta-analysis. Arch Intern Med. (2012); 172(17): 1285-95

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The NEW ENGLAND JOURNAL of MEDICINE

ORIGINAL ARTICLE

Cardiovascular Effects of Intensive Lifestyle Intervention in Type 2 Diabetes

The Look AHEAD Research Group*

ABSTRACT

BACKGROUND

Weight loss is recommended for overweight or obese patients with type 2 diabetes on the basis of short-term studies, but long-term effects on cardiovascular disease remain unknown. We examined whether an intensive lifestyle intervention for weight loss would decrease cardiovascular morbidity and mortality among such patients.

METHODS

In 16 study centers in the United States, we randomly assigned 5145 overweight or obese patients with type 2 diabetes to participate in an intensive lifestyle intervention that promoted weight loss through decreased caloric intake and increased physical activity (intervention group) or to receive diabetes support and education (control group). The primary outcome was a composite of death from cardiovascular causes, nonfatal myocardial infarction, nonfatal stroke, or hospitalization for angina during a maximum follow-up of 13.5 years.

RESULTS

The trial was stopped early on the basis of a futility analysis when the median follow-up was 9.6 years. Weight loss was greater in the intervention group than in the control group throughout the study (8.6% vs. 0.7% at 1 year; 6.0% vs. 3.5% at study end). The intensive lifestyle intervention also produced greater reductions in glycated hemoglobin and greater initial improvements in fitness and all cardiovascular risk factors, except for low-density-lipoprotein cholesterol levels. The primary outcome occurred in 403 patients in the intervention group and in 418 in the control group (1.83 and 1.92 events per 100 person-years, respectively; hazard ratio in the intervention group, 0.95; 95% confidence interval, 0.83 to 1.09; P=0.51).

CONCLUSIONS

An intensive lifestyle intervention focusing on weight loss did not reduce the rate of cardiovascular events in overweight or obese adults with type 2 diabetes. (Funded by the National Institutes of Health and others; Look AHEAD ClinicalTrials.gov number, NCT00017953.)

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*A complete list of participants in the Look AHEAD (Action for Health in Diabetes) Research Group is provided in the Supplementary Appendix, available at NEJM.org.

This article was published on June 24, 2013, at NEJM.org.

N Engl J Med 2013.
DOI: 10.1056/NEJMoa1212914

The Look AHEAD Research Group: Reduction in Weight and Cardiovaskular Disease Risk Factors in Individuals with Type 2 Diabetes. Diabetes Care (2007) 30: 1374-1383

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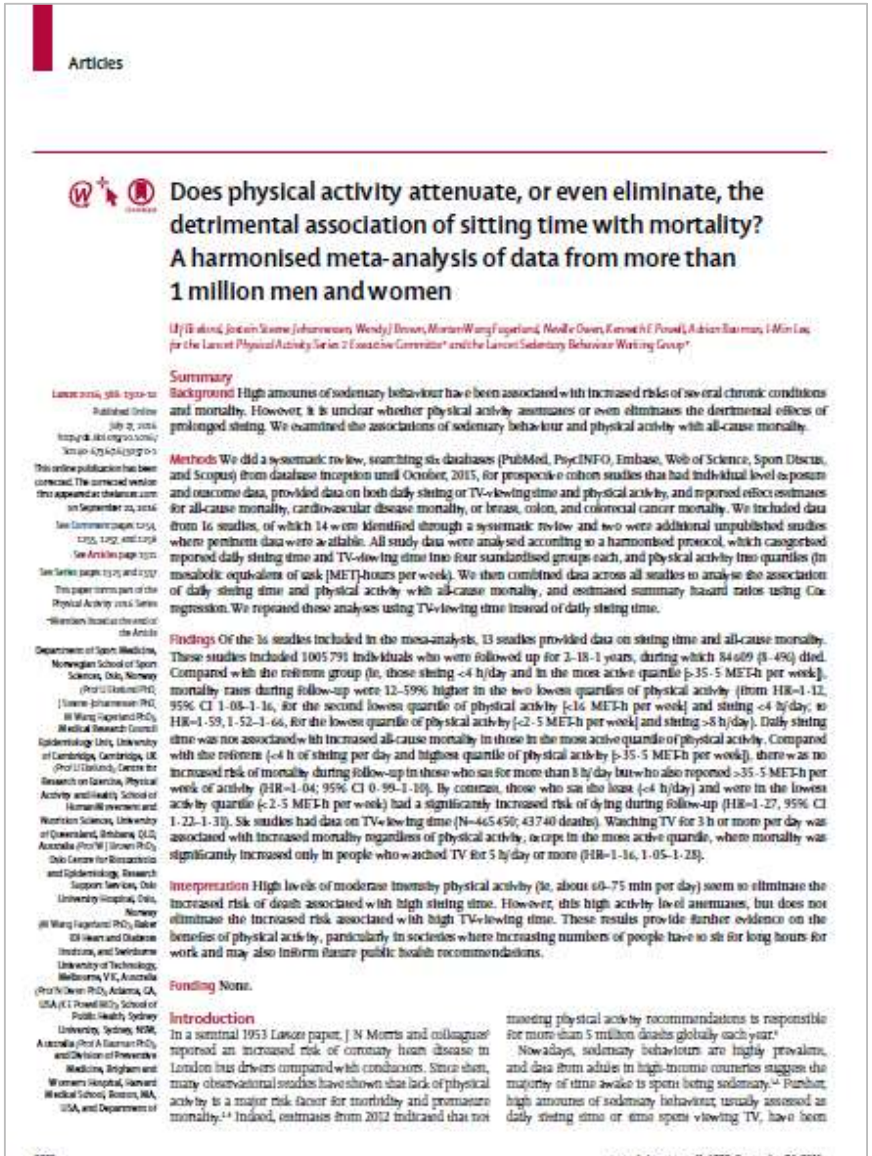

Articles

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

Ulf Ekelund, Jostein Steene-Johannessen, Wendy J Brown, Morten Wang Fagerland, Neville Owen, Kenneth E Powell, Adrian Bauman, I-Min Lee, for the Lancet Physical Activity Series 2 Executive Committee* and the Lancet Sedentary Behaviour Working Group*

Summary

Background High amounts of sedentary behaviour have been associated with increased risks of several chronic conditions and mortality. However, it is unclear whether physical activity attenuates or even eliminates the detrimental effects of prolonged sitting. We examined the associations of sedentary behaviour and physical activity with all-cause mortality.

Methods We did a systematic review, searching six databases (PubMed, PsycINFO, Embase, Web of Science, Sport Discus, and Scopus) from database inception until October, 2015, for prospective cohort studies that had individual level exposure and outcome data, provided data on both daily sitting or TV-viewing time and physical activity, and reported effect estimates for all-cause mortality, cardiovascular disease mortality, or breast, colon, and colorectal cancer mortality. We included data from 16 studies, of which 14 were identified through a systematic review and two were additional unpublished studies where pertinent data were available. All study data were analysed according to a harmonised protocol, which categorised reported daily sitting time and TV-viewing time into four standardised groups each, and physical activity into quartiles (in metabolic equivalent of task [MET]-hours per week). We then combined data across all studies to analyse the association of daily sitting time and physical activity with all-cause mortality, and estimated summary hazard ratios using Cox regression. We repeated these analyses using TV-viewing time instead of daily sitting time.

Findings Of the 16 studies included in the meta-analysis, 13 studies provided data on sitting time and all-cause mortality. These studies included 1 005 791 individuals who were followed up for 2–18·1 years, during which 84 609 (8·4%) died. Compared with the referent group (ie, those sitting <4 h/day and in the most active quartile [>35·5 MET-h per week]), mortality rates during follow-up were 12–59% higher in the two lowest quartiles of physical activity (from HR=1·12, 95% CI 1·08–1·16, for the second lowest quartile of physical activity [<16 MET-h per week] and sitting <4 h/day; to HR=1·59, 1·52–1·66, for the lowest quartile of physical activity [<2·5 MET-h per week] and sitting >8 h/day). Daily sitting time was not associated with increased all-cause mortality in those in the most active quartile of physical activity. Compared with the referent (<4 h of sitting per day and highest quartile of physical activity [>35·5 MET-h per week]), there was no increased risk of mortality during follow-up in those who sat for more than 8 h/day but who also reported >35·5 MET-h per week of activity (HR=1·04; 95% CI 0·99–1·10). By contrast, those who sat the least (<4 h/day) and were in the lowest activity quartile (<2·5 MET-h per week) had a significantly increased risk of dying during follow-up (HR=1·27, 95% CI 1·22–1·31). Six studies had data on TV-viewing time (N=465 450; 43 740 deaths). Watching TV for 3 h or more per day was associated with increased mortality regardless of physical activity, except in the most active quartile, where mortality was significantly increased only in people who watched TV for 5 h/day or more (HR=1·16, 1·05–1·28).

Interpretation High levels of moderate intensity physical activity (ie, about 60–75 min per day) seem to eliminate the increased risk of death associated with high sitting time. However, this high activity level attenuates, but does not eliminate the increased risk associated with high TV-viewing time. These results provide further evidence on the benefits of physical activity, particularly in societies where increasing numbers of people have to sit for long hours for work and may also inform future public health recommendations.

Funding None.

Introduction

In a seminal 1953 Lancet paper, J N Morris and colleagues[1] reported an increased risk of coronary heart disease in London bus drivers compared with conductors. ...

... meeting physical activity recommendations is responsible for more than 5 million deaths globally each year.[4]

Ekelund 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 2016 (388): 1302–10

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RESEARCH

OPEN ACCESS

Physical activity and risk of breast cancer, colon cancer, diabetes, ischemic heart disease, and ischemic stroke events: systematic review and dose-response meta-analysis for the Global Burden of Disease Study 2013

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Additional material is published online only. To view please visit the journal online.

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Accepted: 01 July 2016

ABSTRACT

OBJECTIVE
To quantify the dose-response associations between total physical activity and risk of breast cancer, colon cancer, diabetes, ischemic heart disease, and ischemic stroke events.

DESIGN
Systematic review and Bayesian dose-response meta-analysis.

DATA SOURCES
PubMed and Embase from 1980 to 27 February 2016, and references from relevant systematic reviews. Data from the Study on Global AGEing and Adult Health conducted in China, Ghana, India, Mexico, Russia, and South Africa from 2007 to 2010 and the US National Health and Nutrition Examination Surveys from 1999 to 2011 were used to map domain specific physical activity (reported in included studies) to total activity.

ELIGIBILITY CRITERIA FOR SELECTING STUDIES
Prospective cohort studies examining the associations between physical activity (any domain) and at least one of the five diseases studied.

RESULTS
174 articles were identified: 35 for breast cancer, 19 for colon cancer, 55 for diabetes, 43 for ischemic heart disease, and 26 for ischemic stroke (some articles included multiple outcomes). Although higher levels of total physical activity were significantly associated with lower risk for all outcomes, major gains occurred at lower levels of activity (up to 3000-4000 metabolic equivalent (MET) minutes/week). For example, individuals with a total activity level of 600 MET minutes/week (the minimum recommended level) had a 2% lower risk of diabetes compared with those reporting no physical activity. An increase from 600 to 3600 MET minutes/week reduced the risk by an additional 19%. The same amount of increase yielded much smaller returns at higher levels of activity: an increase of total activity from 9000 to 12 000 MET minutes/week reduced the risk of diabetes by only 0.6%. Compared with insufficiently active individuals (total activity <600 MET minutes/week), the risk reduction for those in the highly active category (≥8000 MET minutes/week) was 14% (relative risk 0.863, 95% uncertainty interval 0.829 to 0.900) for breast cancer; 21% (0.789, 0.735 to 0.850) for colon cancer; 28% (0.722, 0.678 to 0.768) for diabetes; 25% (0.754, 0.704 to 0.809) for ischemic heart disease; and 26% (0.736, 0.659 to 0.811) for ischemic stroke.

CONCLUSIONS
People who achieve total physical activity levels several times higher than the current recommended minimum level have a significant reduction in the risk of the five diseases studied. More studies with detailed quantification of total physical activity will help to find more precise relative risk estimates for different levels of activity.

WHAT IS ALREADY KNOWN ON THIS TOPIC

Many cohort studies and meta-analyses have shown the health benefits of physical activity, resulting in WHO recommending a minimum total physical activity level (irrespective of domains including leisure time, household, occupation, and/or transportation) of 600 MET minutes a week, but the upper limit of total activity required is not known

Meta-analyses that examined the dose-response associations between physical activity and chronic diseases focused mainly on a single domain of activity such as leisure time physical activity, which constitutes a relatively small part of total daily activity, and thus the relation between total physical activity and chronic diseases has not been well characterized

WHAT THIS STUDY ADDS

This dose-response meta-analysis focused on total physical activity across different domains of life (leisure time, occupation, domestic, transportation) and included about three to five times more prospective cohort studies than previous dose-response meta-analyses that focused on a single domain of activity only

The continuous risk curves for the associations between total physical activity and breast cancer, colon cancer, diabetes, ischemic heart disease, and ischemic stroke show that although the risks of these diseases decrease with increasing level of total activity, most health gains occur at relatively lower levels of activity (up to 3000-4000 MET minutes/week), with diminishing returns at higher levels of activity

Introduction

Although the protective effect of physical activity on various chronic diseases is well studied and supported in the literature, relatively few studies have systematically quantified the dose-response relations between physical activity and chronic disease endpoints. Systematic reviews that examined the dose-response associations between physical activity and breast cancer,[1] diabetes,[2] ischemic heart disease,[3] or any cancer[4] focused mainly on a single domain such as leisure time physical activity.[1-4] As leisure time

Kyu HH et al: Physical activity and risk of breast cancer, colon cancer, diabetes, ischemic heart disease, and ischemic stroke events: systematic review and dose-response meta-analysis for the Global Burden of Disease Study 2013. BMJ 354: i3857, 2016

MET – brauche ich nicht?!

Studien verstehen

Diabeteszentrum Minden

5. LIFESTYLE MANAGEMENT

Check for updates

5. Lifestyle Management: *Standards of Medical Care in Diabetes—2019*

American Diabetes Association

Diabetes Care 2019;42(Suppl. 1):S46–S60 | https://doi.org/10.2337/dc19-S005

The American Diabetes Association (ADA) "Standards of Medical Care in Diabetes" includes ADA's current clinical practice recommendations and is intended to provide the components of diabetes care, general treatment goals and guidelines, and tools to evaluate quality of care. Members of the ADA Professional Practice Committee, a multidisciplinary expert committee, are responsible for updating the Standards of Care annually, or more frequently as warranted. For a detailed description of ADA standards, statements, and reports, as well as the evidence-grading system for ADA's clinical practice recommendations, please refer to the Standards of Care Introduction. Readers who wish to comment on the Standards of Care are invited to do so at professional.diabetes.org/SOC.

Lifestyle management is a fundamental aspect of diabetes care and includes diabetes self-management education and support (DSMES), medical nutrition therapy (MNT), physical activity, smoking cessation counseling, and psychosocial care. Patients and care providers should focus together on how to optimize lifestyle from the time of the initial comprehensive medical evaluation, throughout all subsequent evaluations and follow-up, and during the assessment of complications and management of comorbid conditions in order to enhance diabetes care.

DIABETES SELF-MANAGEMENT EDUCATION AND SUPPORT

Recommendations

5.1 In accordance with the national standards for diabetes self-management education and support, all people with diabetes should participate in diabetes self-management education to facilitate the knowledge, skills, and ability necessary for diabetes self-care. Diabetes self-management support is additionally recommended to assist with implementing and sustaining skills and behaviors needed for ongoing self-management. **B**

5.2 There are four critical times to evaluate the need for diabetes self-management education and support: at diagnosis, annually, when complicating factors arise, and when transitions in care occur. **E**

5.3 Clinical outcomes, health status, and quality of life are key goals of diabetes self-management education and support that should be measured as part of routine care. **C**

5.4 Diabetes self-management education and support should be patient centered, may be given in group or individual settings or using technology, and should be communicated with the entire diabetes care team. **A**

5.5 Because diabetes self-management education and support can improve outcomes and reduce costs **B**, adequate reimbursement by third-party payers is recommended. **E**

Suggested citation: American Diabetes Association. 5. Lifestyle management: Standards of Medical Care in Diabetes—2019. Diabetes Care 2019;42(Suppl. 1):S46–S60

ADA: Standards of Medical Care in Diabetes. Lifestyle Management.
Diabetes Care 2019;42(Suppl. 1):S46–S60 | https://doi.org/10.2337/dc19-S005

MET verstehen-
Leistung und Energieverbrauch beim Sport einfach abschätzen

MET – brauche ich nicht?!
Nachsitzen: Physikunterricht
Von MET im Praxisalltag profitieren

Nachsitzen: Physikunterricht

Definition: MET beschreibt das Verhältnis von Arbeits- zu Ruhe-Energieumsatz

1 MET (metabolisches Äquivalent)
ist dabei das Maß für die Sauerstoff-(O_2)-Aufnahme bzw. den Kalorienverbrauch einer erwachsenen Person im ruhigen Sitzen.

1 MET (metabolisches Äquivalent)
entspricht dem Kalorienverbrauch von 1 kcal pro kg Körpergewicht pro Stunde
oder
der Sauerstoffaufnahme (VO_2) von 3,5 Milliliter (ml) pro Minute und kg Körpergewicht.

Ainsworth et al: Compendium of Physical Activities: a second update of codes and MET values. Medicine and Science in Sports and Exercise, 2011;43(8):1575-81.

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Medicine and Science in Sports and Exercise, 2011;43(8):1575-81.

Nachsitzen: Physikunterricht

MET: Maß für die Leistung

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Einheit Leistung: **Watt**

$$\textbf{Leistung} = \frac{\text{Energieverbrauch}}{\text{Zeit}}$$

1 MET (metabolisches Äquivalent)
entspricht dem Kalorienverbrauch von 1 kcal pro kg Köpergewicht pro Stunde

Bildnachweis: shaun-dakin-3490063 on unsplash

Ainsworth et al: Compendium of Physical Activities: a second update of
Medicine and Science in Sports and Exercise, 2011;43(8):1575-81.

Stromverbrauch = Energieverbrauch [Wh]

=

Leistung [W] x Zeit [h]

Stromverbrauch = Energieverbrauch [Wh]
=
Leistung [W] x Zeit [h]

MET

Energieverbrauch [METh]
=
Leistung [MET] x Zeit [h]

MET verstehen-
Leistung und Energieverbrauch beim Sport einfach abschätzen

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Bildnachweis: fotolia

MET – brauche ich nicht?!
Nachsitzen: Physikunterricht
Von MET im Praxisalltag profitieren

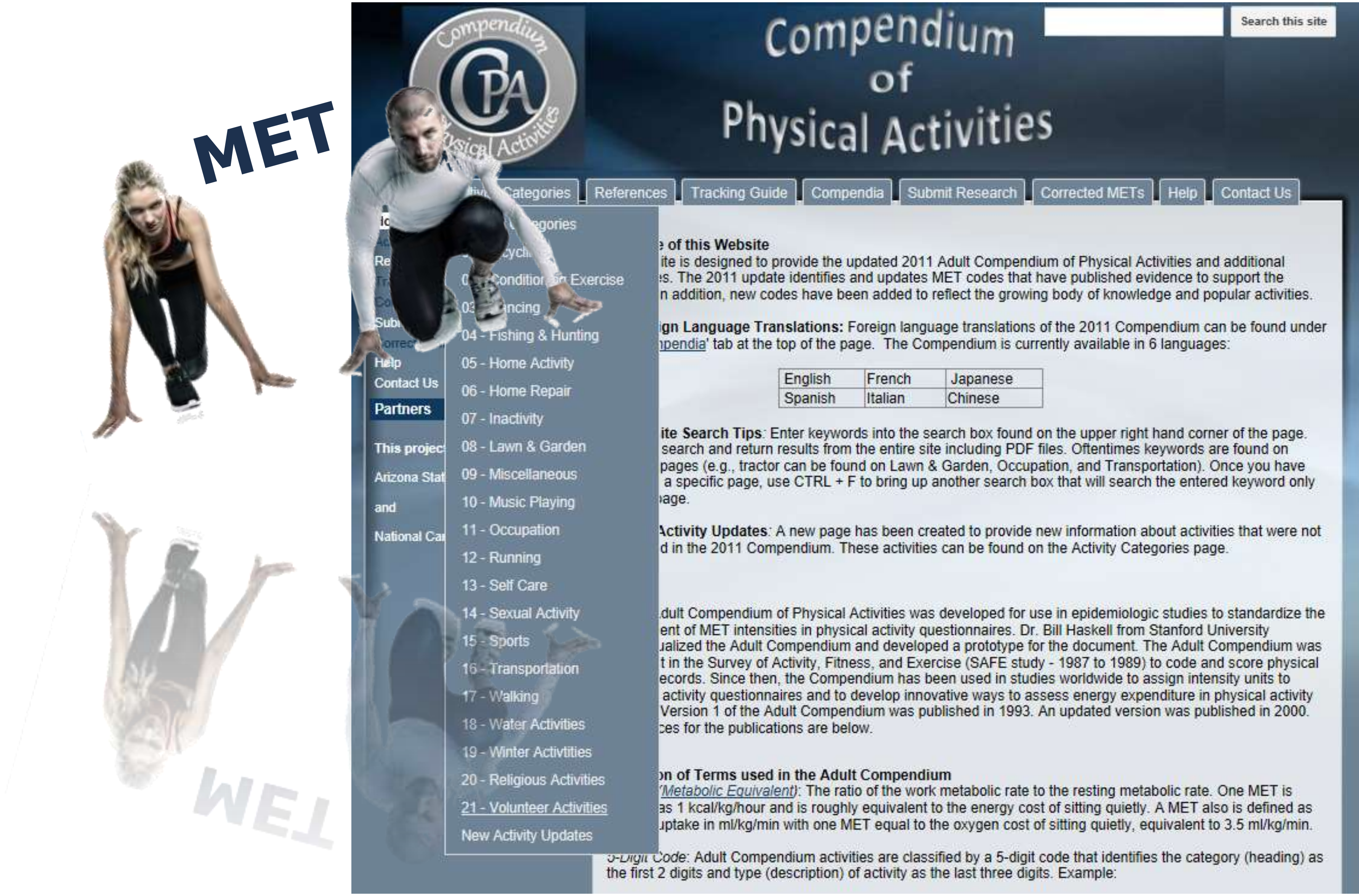
Leistung

Energieverbrauch

Leistung

Von MET im Praxisalltag profitieren

Leistung bei körperlicher Aktivität vergleichen



Ainsworth et al: Compendium of Physical Activities: a second update of codes and MET values. Medicine and Science in Sports and Exercise, 2011;43(8):1575-81.

Von MET im Praxisalltag profitieren

Leistung bei körperlicher Aktivität vergleichen

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Aktivität	MET
Schlafen	0,95
Beten in der Kirche	1,3
Essen	1,5
Autofahren	2,5
Anstreichen	4,5
Kartenspielen	1,5
Lachen im Sitzen	1
Fußball (Breitensport)	7,0
Handball (Breitensport)	8,0
Laufen (langsam, 5km/h)	5,1
Laufen (schnell, 12km/h)	12,4
Nordic Walking (langsam, 4km/h)	4,1
Nordic Walking (schnell, 6km/h)	6,3
Radfahren (gemütlich, zirka 15km/h)	6,0
Radfahren (flott, zirka 25km/h)	10
Radfahren (Heimtrainer, 150 Watt)	7,0
Schwimmen (moderat)	6,0
Schwimmen (intensiv, Kraul)	8,0
Zumba	7,5

Ainsworth et al: Compendium of Physical Activities: a second update of codes and MET values.
Medicine and Science in Sports and Exercise, 2011;43(8):1575-81.

Von MET im Praxisalltag profitieren

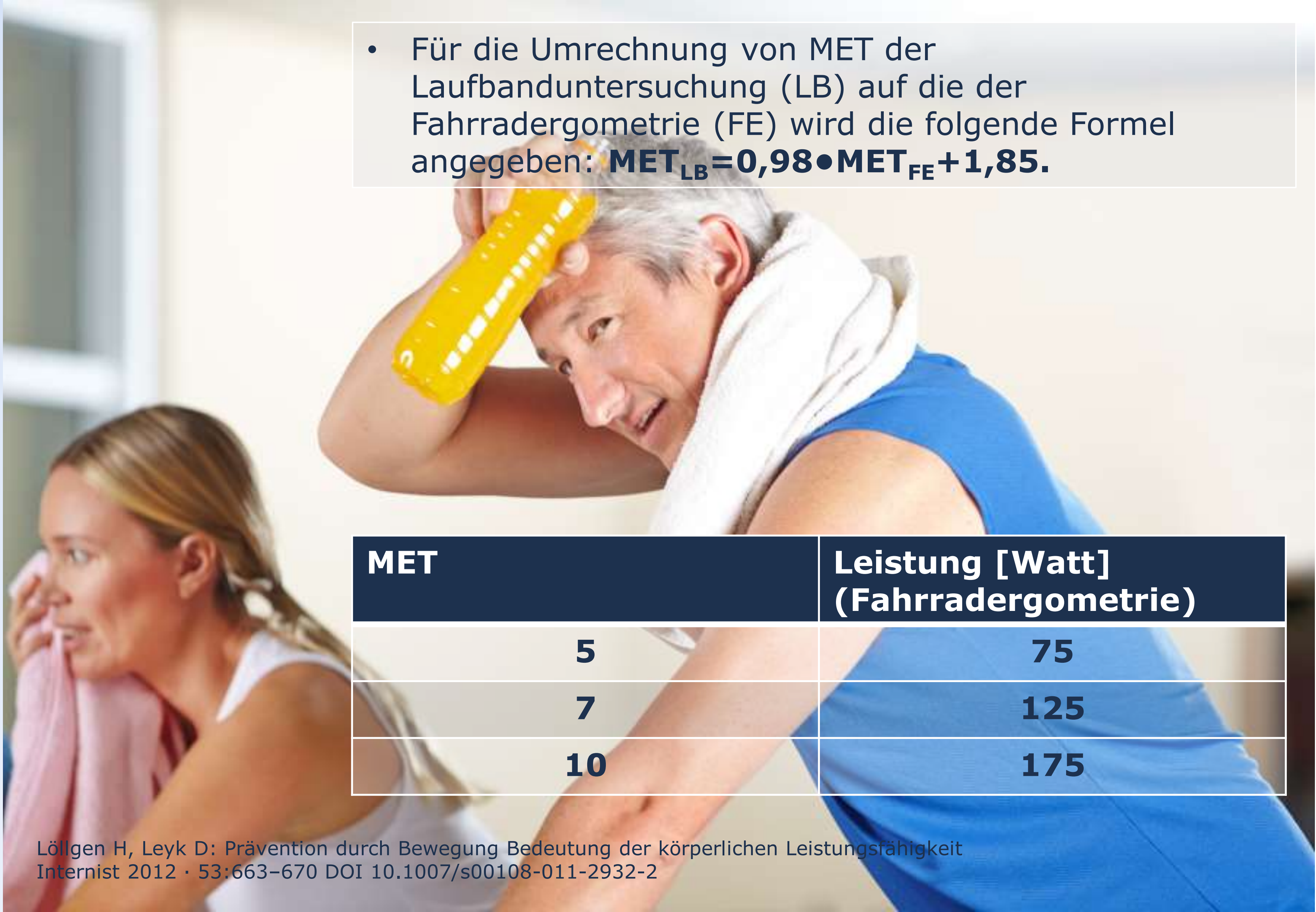
Leistung bei körperlicher Aktivität vergleichen

Intensität	MET
leicht	< 3,0
moderat	3,0 -5,9
intensiv	≥ 6

Ainsworth et al: Compendium of Physical Activities: a second update of codes and MET values. Medicine and Science in Sports and Exercise, 2011;43(8):1575-81.

Von MET im Praxisalltag profitieren

Leistung in der Ergometrie vergleichen



- Für die Umrechnung von MET der Laufbanduntersuchung (LB) auf die der Fahrradergometrie (FE) wird die folgende Formel angegeben: $\mathbf{MET_{LB}=0,98 \bullet MET_{FE}+1,85}$.

MET	Leistung [Watt] (Fahrradergometrie)
5	75
7	125
10	175

Löllgen H, Leyk D: Prävention durch Bewegung Bedeutung der körperlichen Leistungsfähigkeit
Internist 2012 · 53:663–670 DOI 10.1007/s00108-011-2932-2

Von MET im Praxisalltag profitieren

Leistung in der Ergometrie vergleichen

TABLE III Five-level classification of physical activity in terms of exercise intensity

Level	Energy expenditure			
	kcal/min	ml/kg/min	W	METS
Men				
Light	2.0–4.9	6.1–15.2	28–69	1.6–3.9
Moderate	5.0–7.4	15.3–22.9	70–104	4.0–5.9
Heavy	7.5–9.9	23.0–30.6	105–139	6.0–7.9
Very heavy	10.0–12.4	30.7–38.3	140–174	8.0–9.9
Unduly heavy	12.5–	38.4–	175–	10.0–
Women				
Light	1.5–3.4	5.4–12.5	21–48	1.2–2.7
Moderate	3.5–5.4	12.6–19.8	49–76	2.8–4.3
Heavy	5.5–7.4	19.9–27.1	77–104	4.4–5.9
Very heavy	7.5–9.4	27.2–34.4	105–132	6.0–7.5
Unduly heavy	9.5–	34.5–	133–	7.6–

Note: ml/kg based on 65-kg man and 55-kg woman; one MET is equivalent to 250 ml O_2 per minute, or the average resting oxygen consumption.

Adapted from Ref. 2, McArdle er al., Exercise Physiology: Energy, Nutrition, and Human Performuncr, Lea & Febiger, 1986

Von MET im Praxisalltag profitieren

Fitness vergleichen

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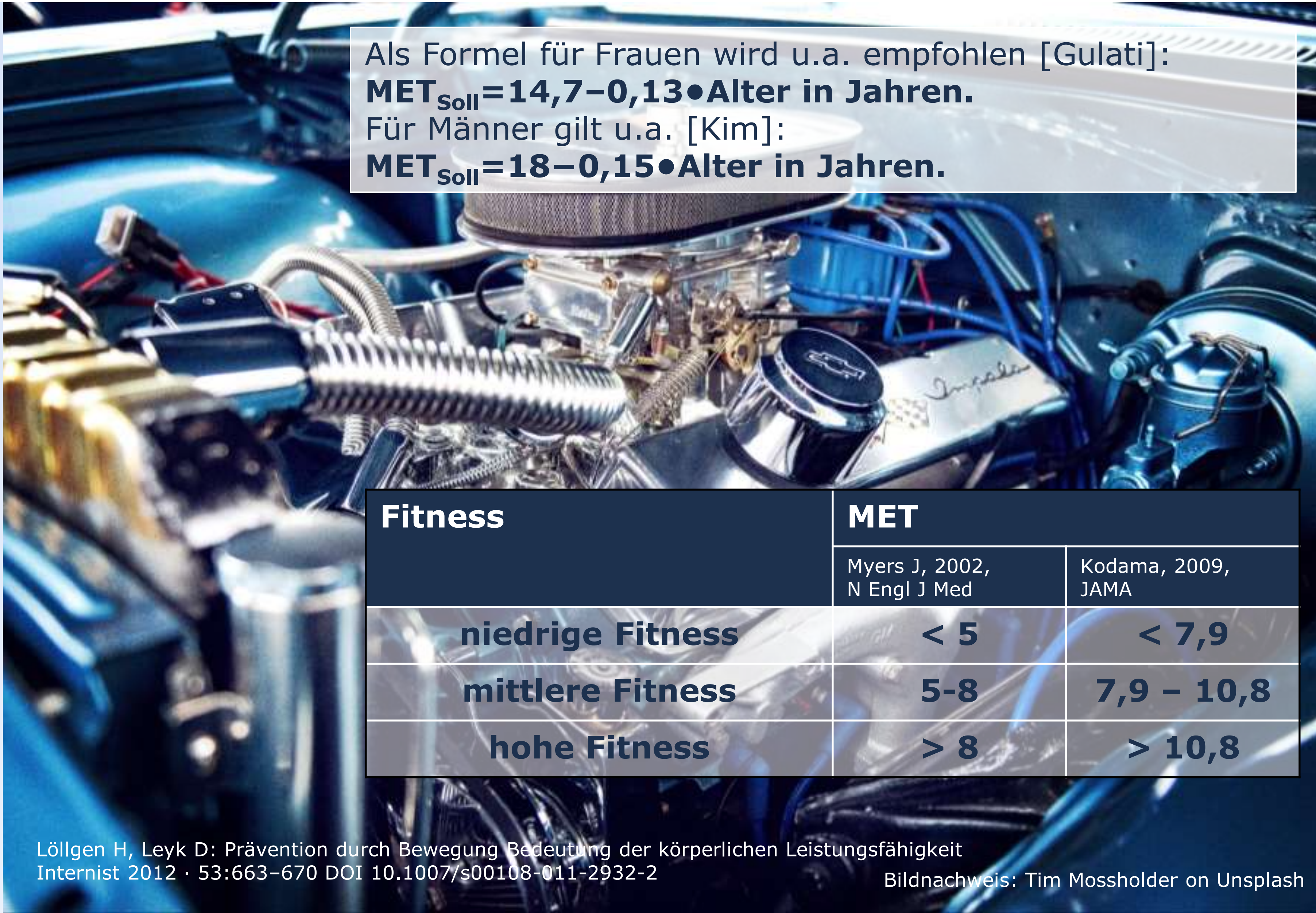

Als Formel für Frauen wird u.a. empfohlen [Gulati]:
MET_{Soll}=14,7–0,13•Alter in Jahren.
Für Männer gilt u.a. [Kim]:
MET_{Soll}=18–0,15•Alter in Jahren.

Fitness	MET	
	Myers J, 2002, N Engl J Med	Kodama, 2009, JAMA
niedrige Fitness	**< 5**	**< 7,9**
mittlere Fitness	**5-8**	**7,9 – 10,8**
hohe Fitness	**> 8**	**> 10,8**

Löllgen H, Leyk D: Prävention durch Bewegung Bedeutung der körperlichen Leistungsfähigkeit
Internist 2012 · 53:663–670 DOI 10.1007/s00108-011-2932-2

Bildnachweis: Tim Mossholder on Unsplash

Energieverbrauch

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1 MET (metabolisches Äquivalent)
entspricht dem Kalorienverbrauch von 1 kcal pro kg Köpergewicht pro Stunde

Energieverbrauch [METh]
=
Leistung [MET] x Zeit [h]

Energieverbrauch [kcal]
=

Leistung $\left[\frac{\text{kcal}}{\text{kg h}}\right]$ x Körpergewicht [kg] x Zeit [h]

Von MET im Praxisalltag profitieren

Energieverbrauch bei körperlicher Aktivität abschätzen

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Energieverbrauch [kcal]

=

$$\text{Leistung}\left[\frac{\text{kcal}}{\text{kg h}}\right] \times \text{Körpergewicht [kg]} \times \text{Zeit [h]}$$

Von MET im Praxisalltag profitieren

Energieverbrauch bei körperlicher Aktivität abschätzen

Energieverbrauch [kcal]

=

MET $\left[\frac{\text{kcal}}{\text{kg h}}\right]$ x Körpergewicht [kg] x Zeit [h]

Spaziergang / MET $\left[\frac{\text{kcal}}{\text{kg h}}\right]$:		3,5
Körpergewicht [kg]:		100
Trainingsdauer [h]:		1,0
Energieverbrauch [kcal]:	3,5 x 1,0 x 100 =	**350**

Bildnachweis: leonides ruvalcabar on Unsplash

Energieverbrauch bei körperlicher Aktivität abschätzen

Energieverbrauch [kcal]

=

Leistung $\left[\frac{kcal}{kg\ h}\right]$ x Körpergewicht [kg] x Zeit [h]

American football / MET $\left[\frac{kcal}{kg\ h}\right]$:	8
Körpergewicht [kg]:	100
Trainingsdauer [h]:	1,5
Energieverbrauch [kcal]:	8 x 1,5 x 100 = **1200**

Bildnachweis: John Torcasio on Unsplash

Von MET im Praxisalltag profitieren

Studien verstehen

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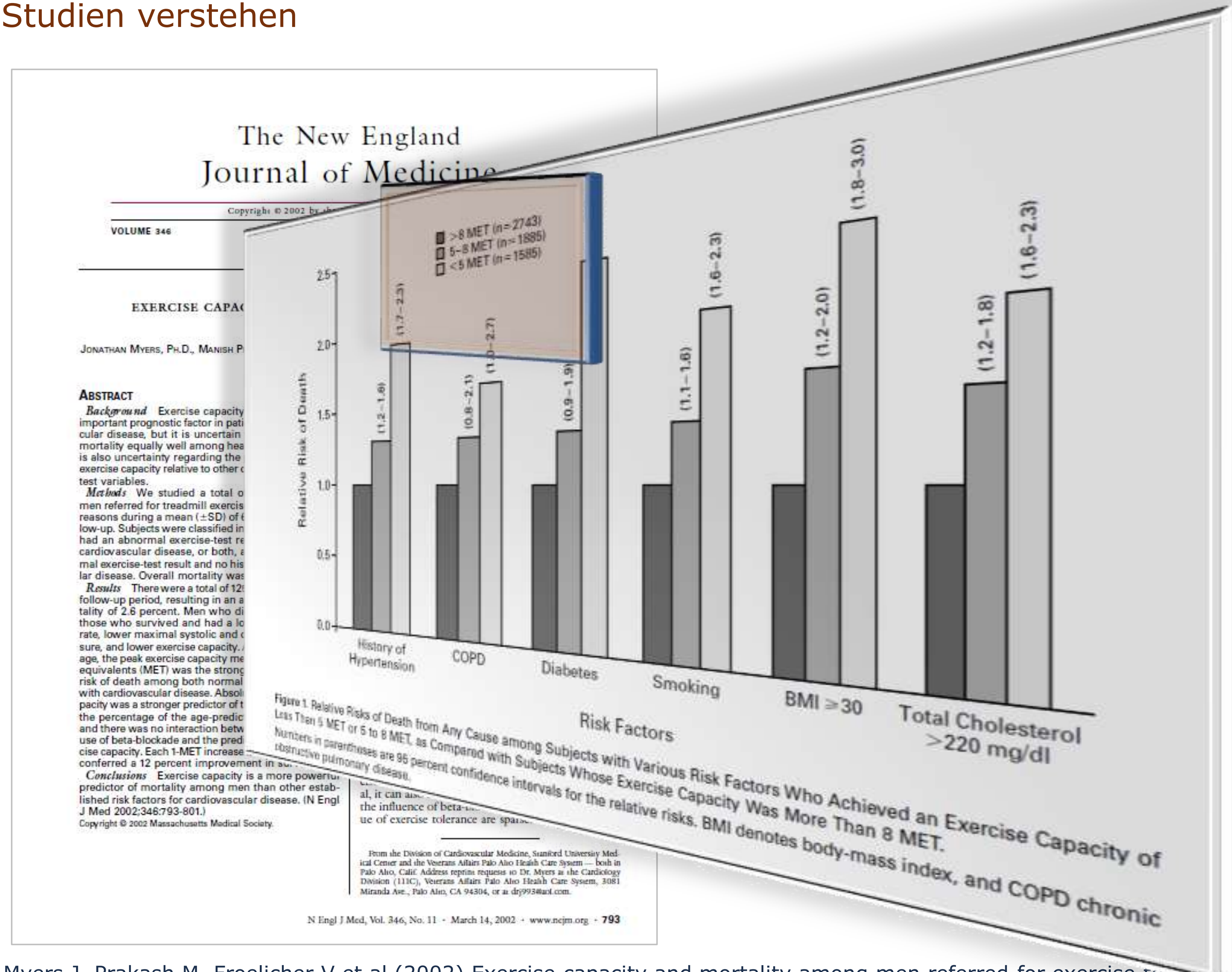


Myers J, Prakash M, Froelicher V et al (2002) Exercise capacity and mortality among men referred for exercise testing. N Engl J Med 346:793–801

Von MET im Praxisalltag profitieren

Studien verstehen

Diabeteszentrum Minden

The NEW ENGLAND JOURNAL of MEDICINE

ORIGINAL ARTICLE

Cardiovascular Effects of Intensive Lifestyle Intervention in Type 2 Diabetes

The Look AHEAD Research Group*

ABSTRACT

BACKGROUND

Weight loss is recommended for overweight or obese patients on the basis of short-term studies, but long-term effects on ca remain unknown. We examined whether an intensive lifest weight loss would decrease cardiovascular morbidity and m patients.

METHODS

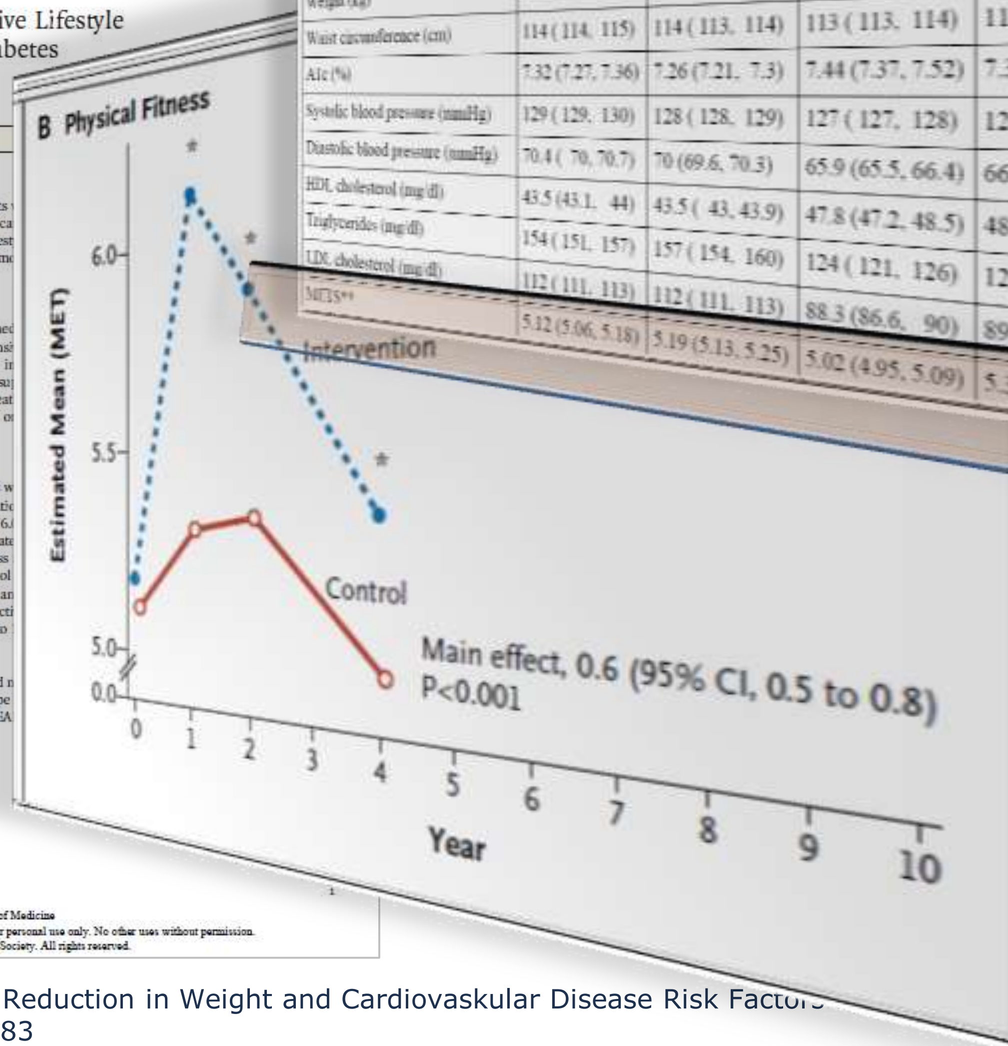
In 16 study centers in the United States, we randomly assigned obese patients with type 2 diabetes to participate in an intensi tion that promoted weight loss through decreased caloric in physical activity (intervention group) or to receive diabetes su (control group). The primary outcome was a composite of deat lar causes, nonfatal myocardial infarction, nonfatal stroke, o angina during a maximum follow-up of 13.5 years.

RESULTS

The trial was stopped early on the basis of a futility analysis w low-up was 9.6 years. Weight loss was greater in the interventi control group throughout the study (8.6% vs. 0.7% at 1 year; 6. end). The intensive lifestyle intervention also produced great cated hemoglobin and greater initial improvements in fitness lar risk factors, except for low-density-lipoprotein cholesterol outcome occurred in 403 patients in the intervention group an trol group (1.83 and 1.92 events per 100 person-years, respecti the intervention group, 0.95; 95% confidence interval, 0.83 to

CONCLUSIONS

An intensive lifestyle intervention focusing on weight loss did n cardiovascular events in overweight or obese adults with type by the National Institutes of Health and others; Look AHEA number, NCT00017953.)



	Baseline		End of Study	
	DSE Mean (95% CI)	ILI Mean (95% CI)	DSE Mean (95% CI)	ILI Mean (95% CI)
Weight (kg)	101 (100, 101)	100 (99.7, 101)	96.2 (95.4, 97)	93.6 (92.8, 94.4)
Waist circumference (cm)	114 (114, 115)	114 (113, 114)	113 (113, 114)	112 (111, 112)
A1c (%)	7.32 (7.27, 7.36)	7.26 (7.21, 7.3)	7.44 (7.37, 7.52)	7.33 (7.25, 7.41)
Systolic blood pressure (mmHg)	129 (129, 130)	128 (128, 129)	127 (127, 128)	126 (125, 127)
Diastolic blood pressure (mmHg)	70.4 (70, 70.7)	70 (69.6, 70.3)	65.9 (65.5, 66.4)	66.3 (65.8, 66.8)
HDL cholesterol (mg/dl)	43.5 (43.1, 44)	43.5 (43, 43.9)	47.8 (47.2, 48.5)	48.7 (48, 49.3)
Triglycerides (mg/dl)	154 (151, 157)	157 (154, 160)	124 (121, 126)	126 (123, 129)
LDL cholesterol (mg/dl)	112 (111, 113)	112 (111, 113)	88.3 (86.6, 90)	89.5 (87.8, 91.1)
METS**	5.12 (5.06, 5.18)	5.19 (5.13, 5.25)	5.02 (4.95, 5.09)	5.38 (5.31, 5.45)

The Look AHEAD Research Group: Reduction in Weight and Cardiovaskular Disease Risk Factor… ith Type 2 Diabetes. Diabetes Care (2007) 30: 1374-1383
Supplement to: The Look AHEAD Research Group. Cardiovascular effects of intensive lifestyle intervention in type 2 diabetes. N Engl J Med 2013;369:145-54. DOI: 10.1056/NEJMoa1212914

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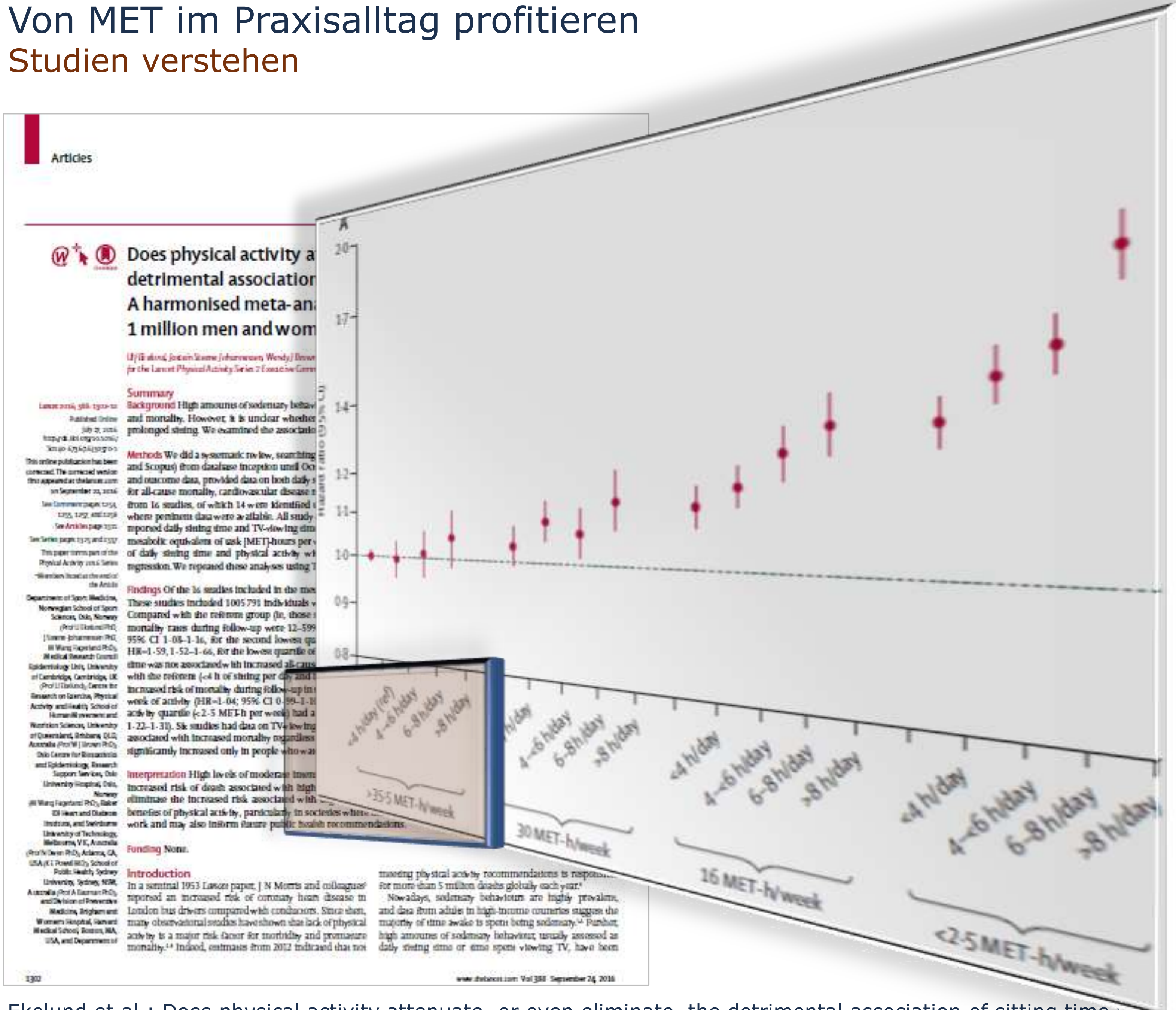

Ekelund et al.: Does physical activity attenuate, or even eliminate, the detrimental association of sitting time [illegible] mortality? A harmonised meta-analysis of data from more than 1 million men and women. Lancet 2016 (388): 1302–10

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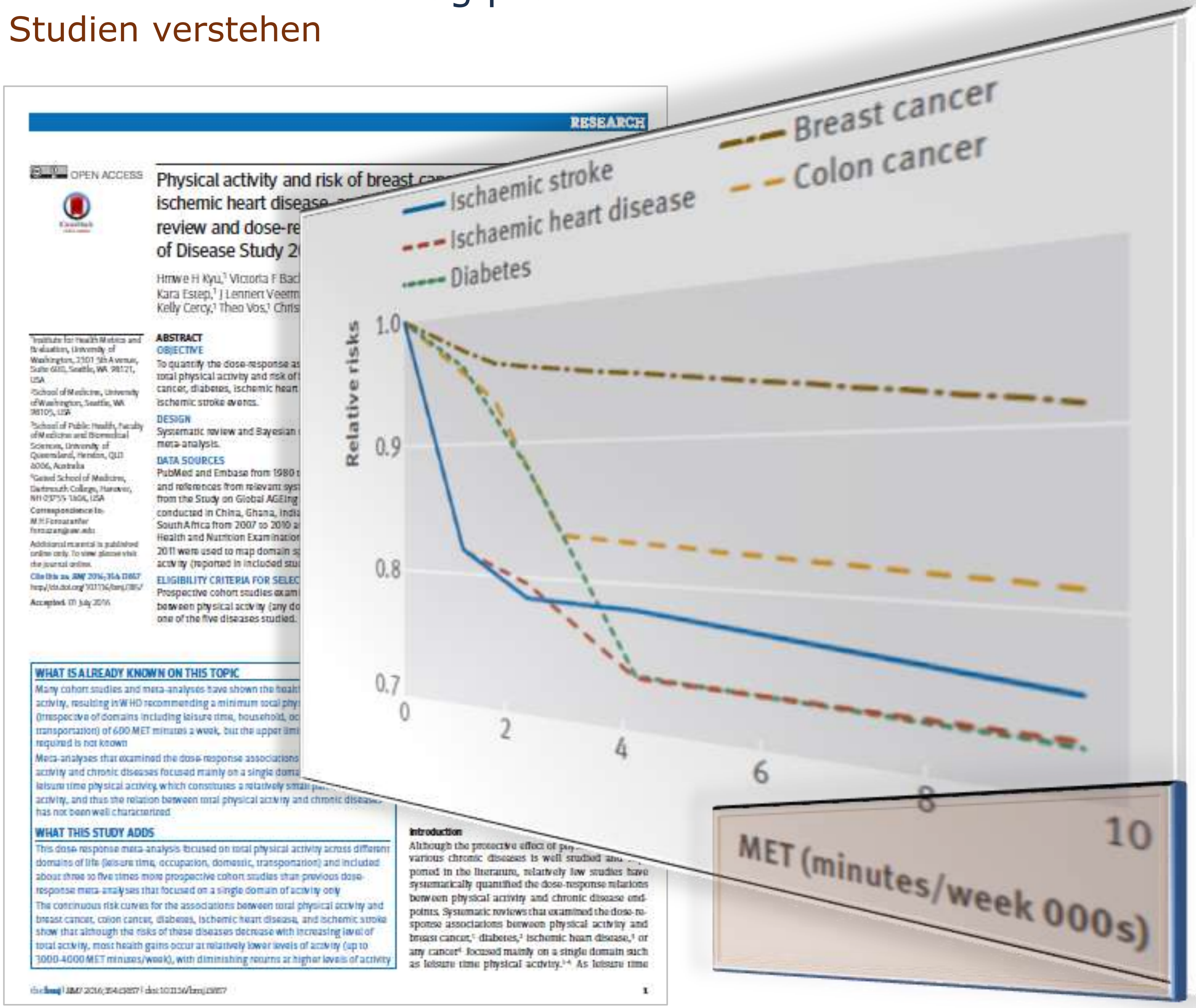

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Von MET im Praxisalltag profitieren

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Check for updates

5. Lifestyle Management: *Standards of Medical Care in Diabetes—2019*

American Diabetes Association

Diabetes Care 2019;42(Suppl. 1):S46–S60 | https:

5. LIFESTYLE MANAGEMENT

The American Diabetes Association (ADA) "Star includes ADA's current clinical practice recomm vide the components of diabetes care, gener and tools to evaluate quality of care. Member Committee, a multidisciplinary expert commi the Standards of Care annually, or more frequ description of ADA standards, statements, an grading system for ADA's clinical practice reco Standards of Care Introduction. Readers who v of Care are invited to do so at professional.di

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DIABETES SELF-MANAGEMENT EDUCATIO

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Suggested citation: American Diabetes Association. 5. Lifestyle management: Standards of Medical Care in Diabetes—2019. Diabetes Care 2019;42(Suppl. 1):S46–S60

TABLE III Five-level classification of physical activity in terms of exercise intensity

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Note: ml/kg based on 65-kg man and 55-kg woman; one MET is equivalent to 250 ml O_2 per minute, or the average resting oxygen consumption.

Adapted from Ref. 2, McArdle et al., Exercise Physiology: Energy, Nutrition, and Human Performance, Lea & Febiger, 1986

10 MET-h

ADA: Standards of Medical Care in Diabetes. Lifestyle Management.
Diabetes Care 2019;42(Suppl. 1):S46–S60 | https://doi.org/10.2337/dc19-S005

Von MET im Praxisalltag profitieren

MET: zu ungenau…?

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entspricht dem Kalorienverbrauch von 1 kcal pro kg Körpergewicht pro Stunde
oder
der Sauerstoffaufnahme (VO_2) von 3,5 Milliliter (ml) pro Minute und kg Körpergewicht.

Bildnachweis: Fotolia

Von MET im Praxisalltag profitieren

MET: zu ungenau…?

Größe, Gewicht
Körperzusammensetzung (Lean body mass (Magermasse))
Kardiorespiratorische Fitness
Trainingszustand
Fertigkeit/ Technik („skills“)

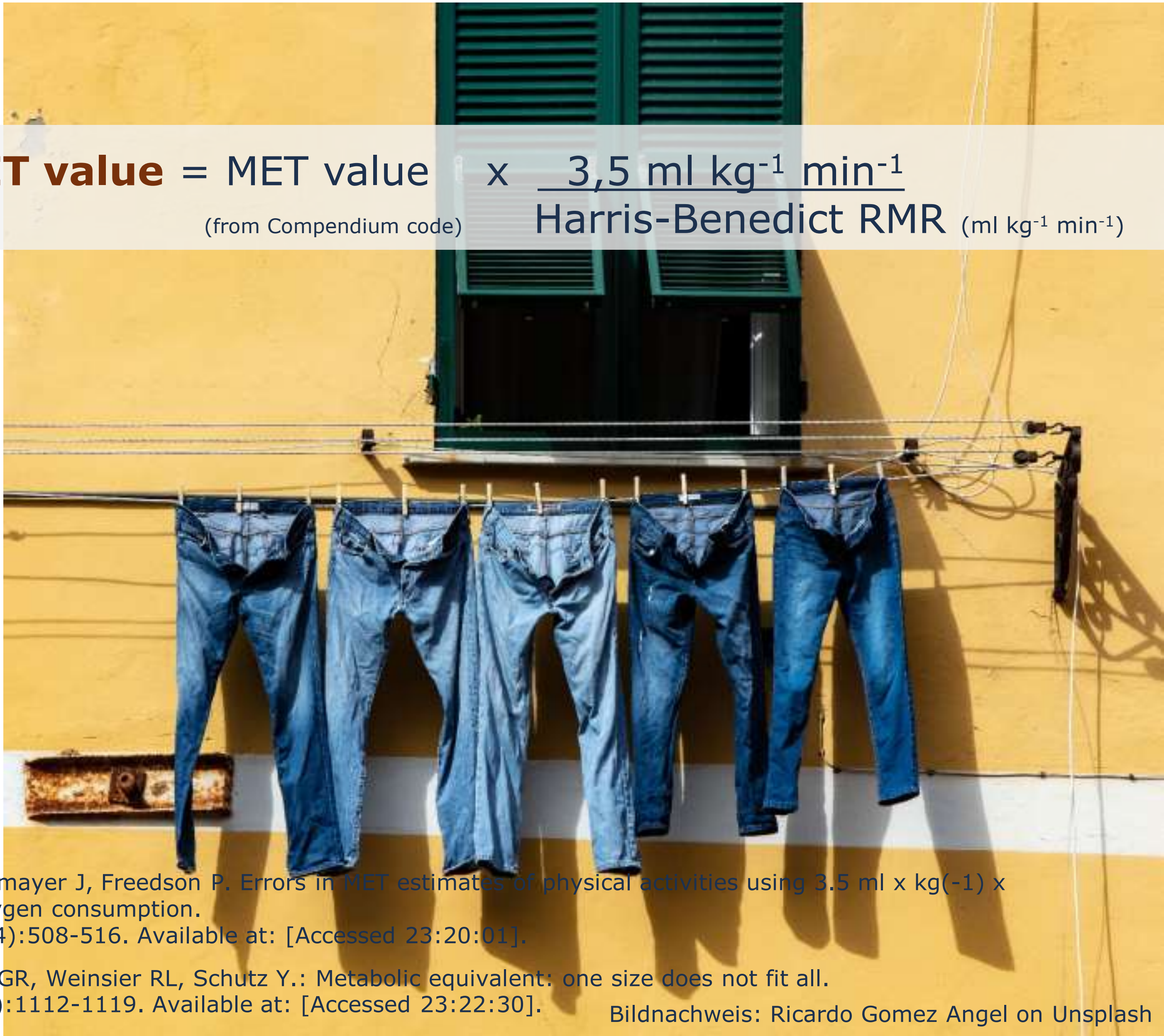
Temperatur
Feuchtigkeit
Wind
Trainingsfläche
Kleidung
Ausrüstung
…

Jetté et al:
Metabolic Equivalents (METS) in Exercise Testing, Exercise Prescription and Evaluation of Functional Capacity.
Clin. Cardiol. (1990) 13, 555-565

Bildnachweis: Fotolia

Von MET im Praxisalltag profitieren

MET: zu ungenau…?



$$\textbf{Corrected MET value} = \text{MET value (from Compendium code)} \times \frac{3{,}5 \text{ ml kg}^{-1} \text{ min}^{-1}}{\text{Harris-Benedict RMR (ml kg}^{-1} \text{ min}^{-1}\text{)}}$$

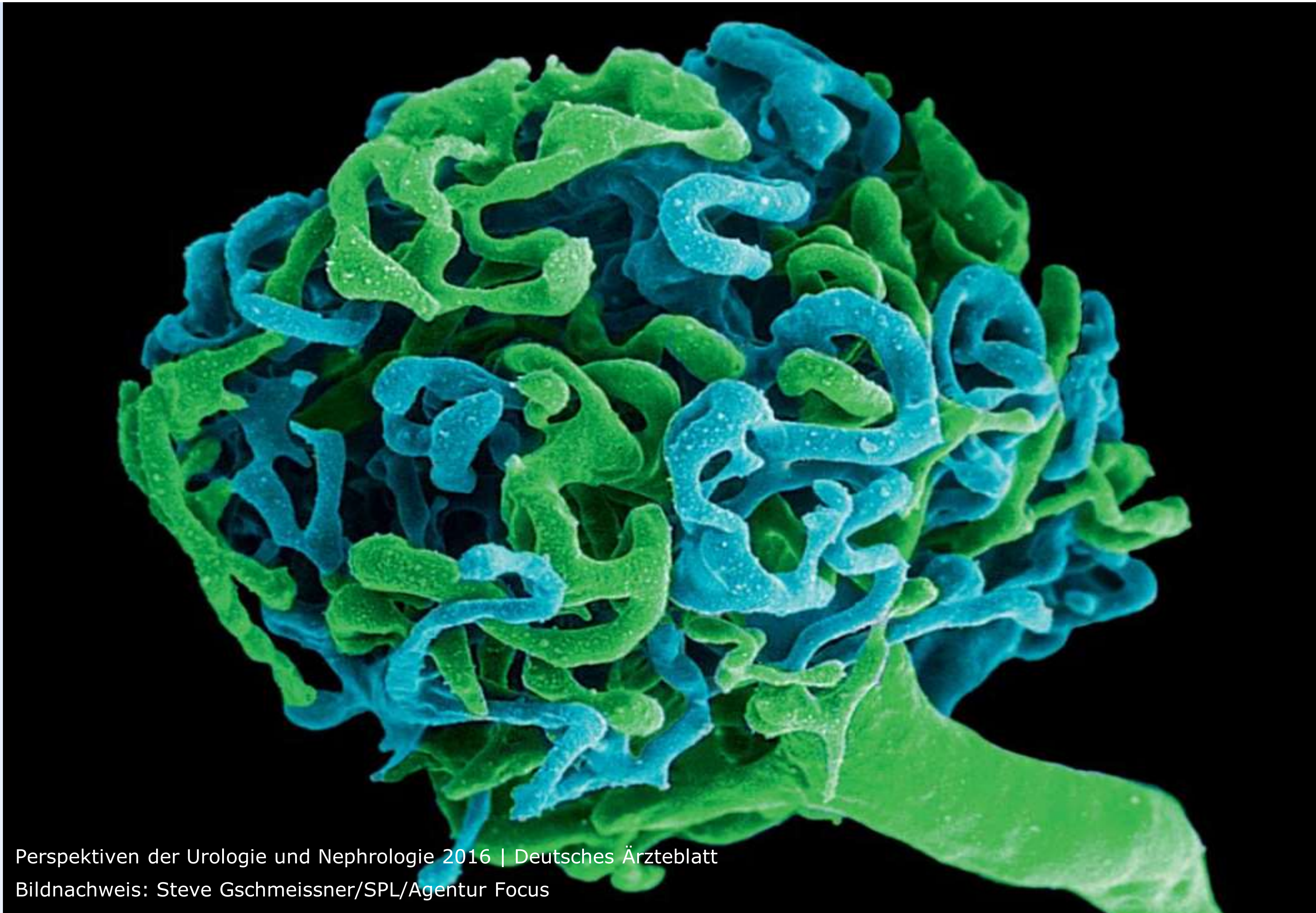
Kozey S, Lyden K, Staudenmayer J, Freedson P. Errors in MET estimates of physical activities using 3.5 ml x kg(-1) x min(-1) as the baseline oxygen consumption.
J Phys Act Health. 2010;7(4):508-516. Available at: [Accessed 23:20:01].

Byrne NM, Hills AP, Hunter GR, Weinsier RL, Schutz Y.: Metabolic equivalent: one size does not fit all.
J. Appl. Physiol. 2005;99(3):1112-1119. Available at: [Accessed 23:22:30].

Bildnachweis: Ricardo Gomez Angel on Unsplash

Von MET im Praxisalltag profitieren

MET: zu ungenau…?



Perspektiven der Urologie und Nephrologie 2016 | Deutsches Ärzteblatt

Bildnachweis: Steve Gschmeissner/SPL/Agentur Focus

Von MET im Praxisalltag profitieren

MET: zu ungenau…?

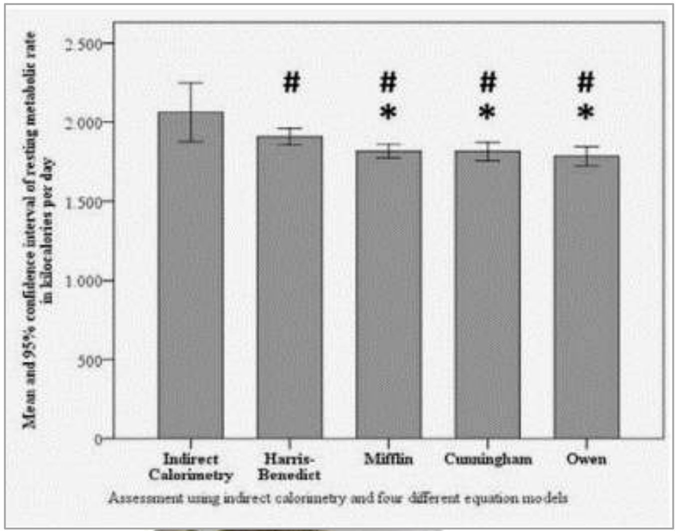
Gesamtumsatz

Gesamtumsatz = **Ruheenergieumsatz** + **Leistungsumsatz**

Bildnachweis: Himanshu Srivastav on Unsplash

Von MET im Praxisalltag profitieren

Ruheenergieumsatzbestimmung –
Die Anwendbarkeit von anthropometriebasierten Formeln im Vergleich zur indirekten Kalorimetrie?



Engeroff T et al.: Resting metabolic rate – the applicability of predictive equations as an alternative to indirect calorimetry. Dtsch Z Sportmed. 2018; 69: 319-325.

Bildnachweis: Cosmed
https://commons.wikimedia.org/wiki/File:Indirect_calorimetry_laboratory_with_canopy_hood.jpg

Gesamtumsatz = **Ruheenergieumsatz** + **Leistungsumsatz**

1823 kcal

189 cm
85 kg
53 Jahre
m

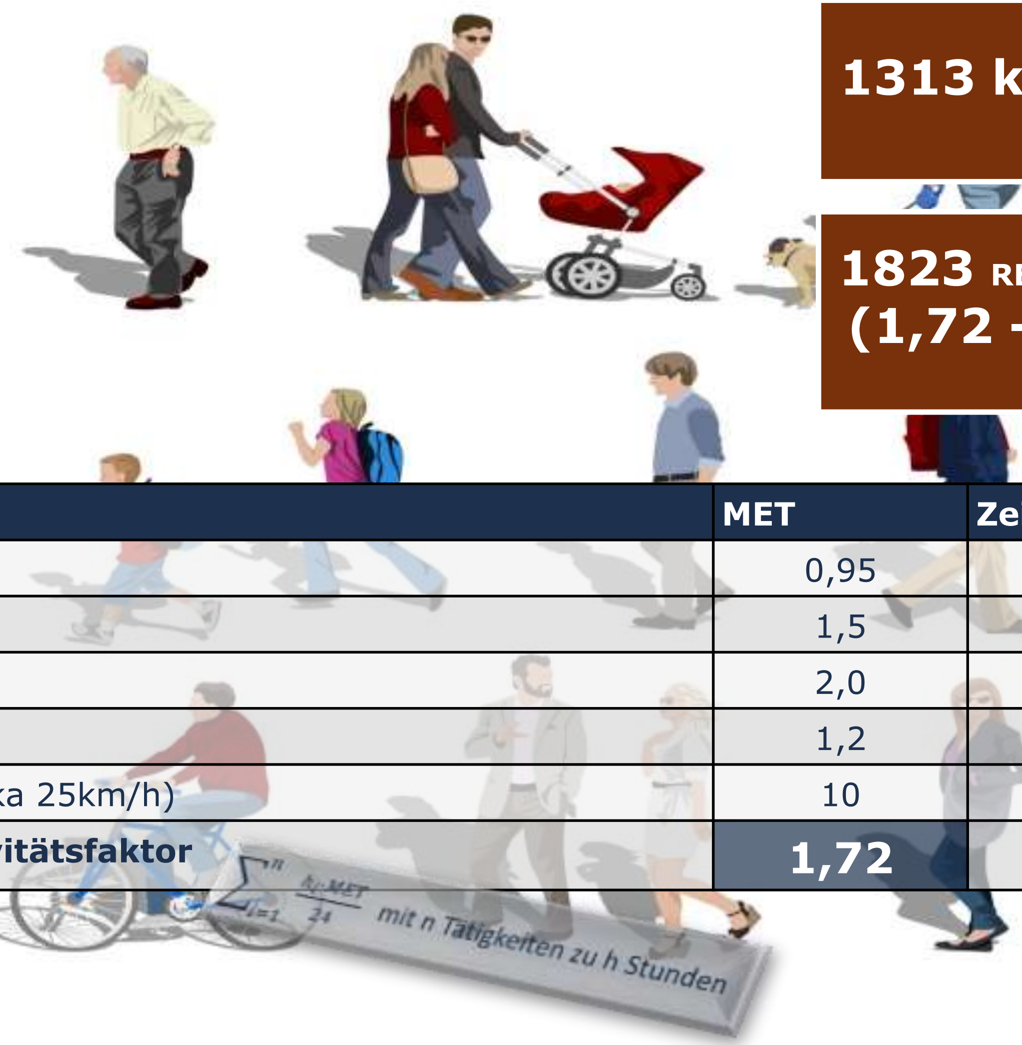
Harris Benedict Formel für den Ruheenergieumsatz (REE)/ Männer **(Kilokalorien pro Tag):**
66.4730 + 5.0033 (Größe cm) + 13.7516 (Gewicht kg) – 6.7550 (Alter Jahren)
Harris Benedict Formel für den Ruheenergieumsatz (REE)/ Frauen **(Kilokalorien pro Tag):**
655.0955 + 1,8496 (Größe cm) + 9,5634 (Gewicht kg) – 4,6756 (Alter Jahren)

Diabeteszentrum Minden

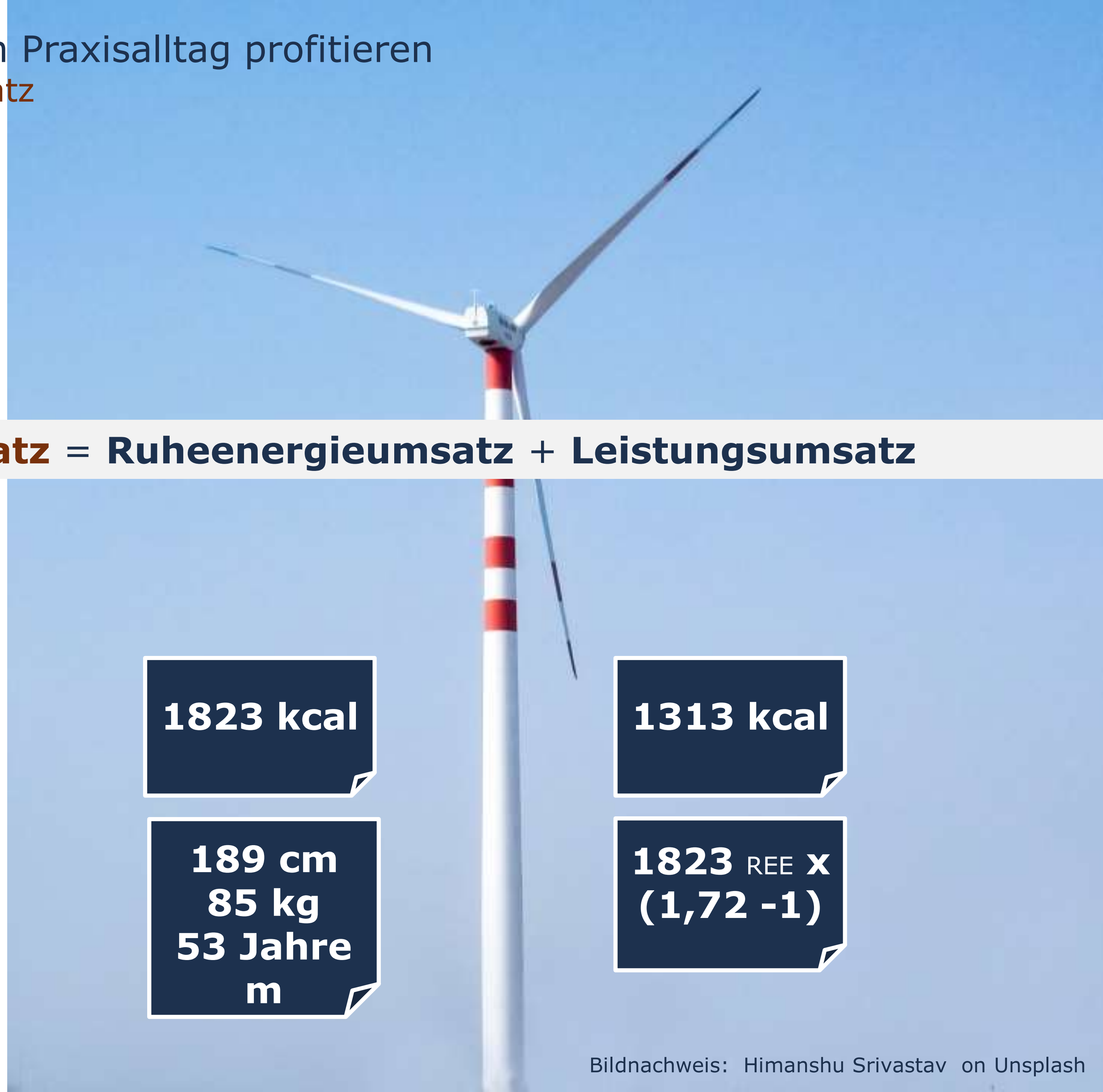
Gesamtumsatz = **Ruheenergieumsatz** + **Leistungsumsatz**

1313 kcal

1823 REE x (1,72 -1)



	MET	Zeit [h]	MET-h
Schlaf	0,95	8	7,6
Büroarbeit	1,5	8	12
Aktive Freizeit	2,0	4	8
Passive Freizeit	1,2	3	3,6
Radfahren (flott, zirka 25km/h)	10	1	10
Individueller Aktivitätsfaktor	**1,72**	24	41,2



Gesamtumsatz = **Ruheenergieumsatz** + **Leistungsumsatz**

3136 kcal

1823 kcal

189 cm
85 kg
53 Jahre
m

1313 kcal

1823 REE **x**
(1,72 -1)

Bildnachweis: Himanshu Srivastav on Unsplash

Von MET im Praxisalltag profitieren

Reichlich Rechner im Internet

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Bildnachweis: 123RF©

MET verstehen-
Leistung und Energieverbrauch beim Sport einfach abschätzen

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Da der Energieumsatz individuell unterschiedlich ist, eignet sich der Vergleich von Aktivitäten mittels MET eigentlich nur für den *relativen* Vergleich des Energieverbrauches einer Person.

Trotz dieser Limitation helfen Metabolische Äquivalente (MET) einfach und leicht verständlich, **Leistung** und **Energieverbrauch** *orientierend* zu quantifizieren.

Wer Broteinheiten/ Kohlenhydrateinheiten schätzt, sollte auch Metabolische Äquivalente (MET) kennen und nutzen.

Take home message

Energieverbrauch *orientierend* einschätzen und vergleichen:

Energieverbrauch [kcal]

=

$$\text{MET}\left[\frac{\text{kcal}}{\text{kg h}}\right] \times \text{Körpergewicht [kg]} \times \text{Zeit [h]}$$

https://sites.google.com/site/compendiumofphysicalactivities/home