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Leisure-time physical activity and incident metabolic syndrome: a systematic review and dose-response meta-analysis of cohort studies



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ABSTRACT

Background. Leisure-time physical activity (LTPA) has been suggested to reduce risk of metabolic syndrome (MetS). However, a quantitative comprehensive assessment of the dose–response association between LTPA and incident MetS has not been reported. We performed a meta-analysis of studies assessing the risk of MetS with LTPA.

Method. MEDLINE via PubMed and EMBase databases were searched for relevant articles published up to March 13, 2017. Random-effects models were used to estimate the summary relative risk (RR) of MetS with LTPA. Restricted cubic splines were used to model the dose–response association.

Results. We identified 16 articles (18 studies including 76,699 participants and 13,871 cases of MetS). We found a negative linear association between LTPA and incident MetS, with a reduction of 8% in MetS risk per 10 metabolic equivalent of task (MET) h/week increment. According to the restricted cubic splines model, risk of MetS was reduced 10% with LTPA performed according to the basic guideline-recommended level of 150 min of moderate PA (MPA) per week (10 MET h/week) versus inactivity (RR = 0.90, 95% CI 0.86–0.94). It was reduced 20% and 53% with LTPA at twice (20 MET h/week) and seven times (70 MET h/week) the basic recommended level (RR = 0.80, 95% CI 0.74–0.88 and 0.47, 95% CI 0.34–0.64, respectively).

Conclusion. Our findings provide quantitative data suggesting that any amount of LTPA is better than none and that LTPA substantially exceeding the current LTPA guidelines is associated with an additional reduction in MetS risk.

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Abbreviations: LTPA, leisure-time physical activity; MetS, metabolic syndrome; PA, physical activity; RR, relative risk; MET, metabolic equivalent of task; MPA, moderate PA; OR, odds ratio; HR, hazard ratio; CI, confidence interval; LPA, light PA; MVPA, moderate to vigorous PA; BMI, body mass index; ATP III, National Cholesterol Education Program Adult Treatment Panel III.

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1. Introduction

Metabolic syndrome (MetS) is characterized by a cluster of cardiovascular risk factors including central obesity, high blood pressure, hypertriglyceridemia, hyperglycemia, and dyslipidemia [1]. Epidemiological studies have indicated that MetS is associated with increased risk of mortality [2] and numerous diseases, including cardiovascular disease [3], cancer [4], kidney disease [5], and diabetes [6]. Over the past decade, the prevalence of MetS increased to 34.7% in the United States and 24.5% in China [7,8]; therefore, there is an urgent need to identify modifiable risk factors to prevent the emerging epidemic.

In recent years, evidence supporting the preventive effect of regular physical activity (PA) for hypertension, cardiovascular disease, diabetes and MetS has grown exponentially [9–12]. Recent public health guidelines [13,14] recommend a minimum of 150 min of moderate PA (MPA) or 75 min of vigorous PA (VPA) per week to maintain general health. However, whether health benefits can be accrued at a lower PA volume and to what degree the PA can reduce the risk of MetS are unclear.

A previous meta-analysis of prospective cohort studies reported reduced risk of MetS with increased level of leisure-time PA (LTPA) [15]. However, the study used only a semi-parametric method to pool high versus low effect size, and no comprehensive assessment of the quantitative dose–response association between PA and MetS risk has been reported. The dose–response curve may provide more detailed PA recommendations for reducing the risk of MetS and crucial information for planning future large-scale randomized trials of PA to prevent disease. We performed a systematic review and meta-analysis of all available data from cohort studies on the dose–response association of LTPA and risk of MetS.

2. Methods

2.1. Literature Search

We searched MEDLINE via PubMed and EMBase databases from their inception up to March 13, 2017 for English-language articles of humans. Details of the search terms used are in Table S1. The reference lists of all included articles [16–31] and previous systematic reviews [15,32] were manually searched for additional relevant studies. The systematic review and meta-analysis was performed in accordance with the Meta-analysis of Observational Studies in Epidemiology (MOOSE) guidelines (Supplementary material 2).

2.2. Study Selection

Cohort studies were included if 1) the type of PA was LTPA; 2) they evaluated the association between LTPA and risk of MetS; 3) they reported relative risks (RRs), odds ratios (ORs) or hazard ratios (HRs) with 95% confidence intervals (CIs); and 4) for the dose–response analysis, they provided at least three exposure levels of PA at baseline, the level-specific case and person-year/participant numbers or sufficient data for deriving these data. If multiple articles based on the same cohort were published, we chose those with the most informative reporting of PA levels and/or the larger sample size. The excluded articles and reasons for exclusion are in Table S2.

2.3. Data Extraction and Quality Assessment

Two authors (DZ and XL) extracted data on the first author, publication year, geographic location, study name, sample size, follow-up period, gender, mean or median age of the study population at baseline, MetS criteria, definition of low,

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