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Review Article

Impact of GH administration on athletic performance in healthy young adults: A systematic review and meta-analysis of placebo-controlled trials

Kasper Hermansen[a,*], Mads Bengtsen[a], Michael Kjær[b], Peter Vestergaard[c,d], Jens Otto Lunde Jørgensen[a]

[a] Department of Endocrinology and Internal Medicine, Aarhus University Hospital, Aarhus, Denmark
[b] Institute of Sports Medicine, Department of Orthopedic Surgery M, Bispebjerg Hospital and Centre for Healthy Aging, Faculty of Health and Medical Science, University of Copenhagen, Denmark
[c] Department of Clinical Medicine, Aalborg University Hospital, Aalborg, Denmark
[d] Department of Endocrinology, Aalborg University Hospital, Aalborg, Denmark

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ABSTRACT

Objective: Illicit use of growth hormone (GH) as a performance-enhancing drug among athletes is prevalent, although the evidence of such effects in healthy, young subjects is sparse. We therefore performed a meta-analysis of published studies on the effect of GH administration on body composition, substrate metabolism, and athletic performance in healthy, young subjects.

Design: The English-language based databases PubMed, EMBASE, and Cochrane Central Register of Controlled Trials were searched, and eligible articles were reviewed in accordance with the PRISMA guidelines. Fifty-four potentially relevant articles were retrieved of which 11 were included in this analysis comprising 254 subjects.

Results: Administration of GH significantly increased lean body mass ($p < 0.01$) and decreased fat mass ($p < 0.01$). In addition, GH increased the exercising levels of glycerol ($p = 0.01$) and free fatty acids ($p < 0.01$), but did not alter the respiratory quotient during exercise ($p = 0.30$). GH significantly increased anaerobic exercise capacity ($p < 0.01$) in the only study which investigated this, but did not over weeks to months improve muscle strength ($p = 0.36$) or maximum oxygen uptake ($p = 0.89$).

Conclusion: GH administration elicits significant changes in body composition, but does not increase either muscle strength or aerobic exercise capacity in healthy, young subjects.

1. Introduction

Illicit use of GH among elite and recreational athletes is widespread and frequently combined with other performance-enhancing drugs [1]. The salutatory effects include reduction in fat mass, increased lean body mass and increased aerobic exercise capacity, which have been documented in GH-replaced adult patients with hypopituitarism [2,3]. However, it is controversial whether GH administration exerts comparable effects in healthy subjects. Nevertheless, GH is considered a doping agent by the World Anti-Doping Agency and its use is prohibited at all times (in and out-of-competition) [4].

The aim of this meta-analysis was to assess the effects of placebo-controlled GH administration on body composition, indices of lipolysis, muscle strength, and exercise capacity in healthy, young subjects.

2. Materials and methods

2.1. Identification of relevant trials

The study was developed in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines [5]. The English-language based databases including PubMed, EMBASE, and the Cochrane Central Register of Controlled Trials (CENTRAL) were searched to identify potentially relevant studies. All databases were comprehensively searched from their respective inception until 2th December 2016 without restrictions to language or date of publication. The search was limited to human adults (19 + years of age). Where possible, the following MeSH terms were used: “growth hormone” in combination with either “sports”, “performance”, “exercise”, or “doping” (details in Appendix A). To ensure the inclusion of studies not yet indexed with MeSH terms, a free text search was performed using the same terms. In addition, the

* Corresponding author.
E-mail address: kasperhermansen@hotmail.dk (K. Hermansen).

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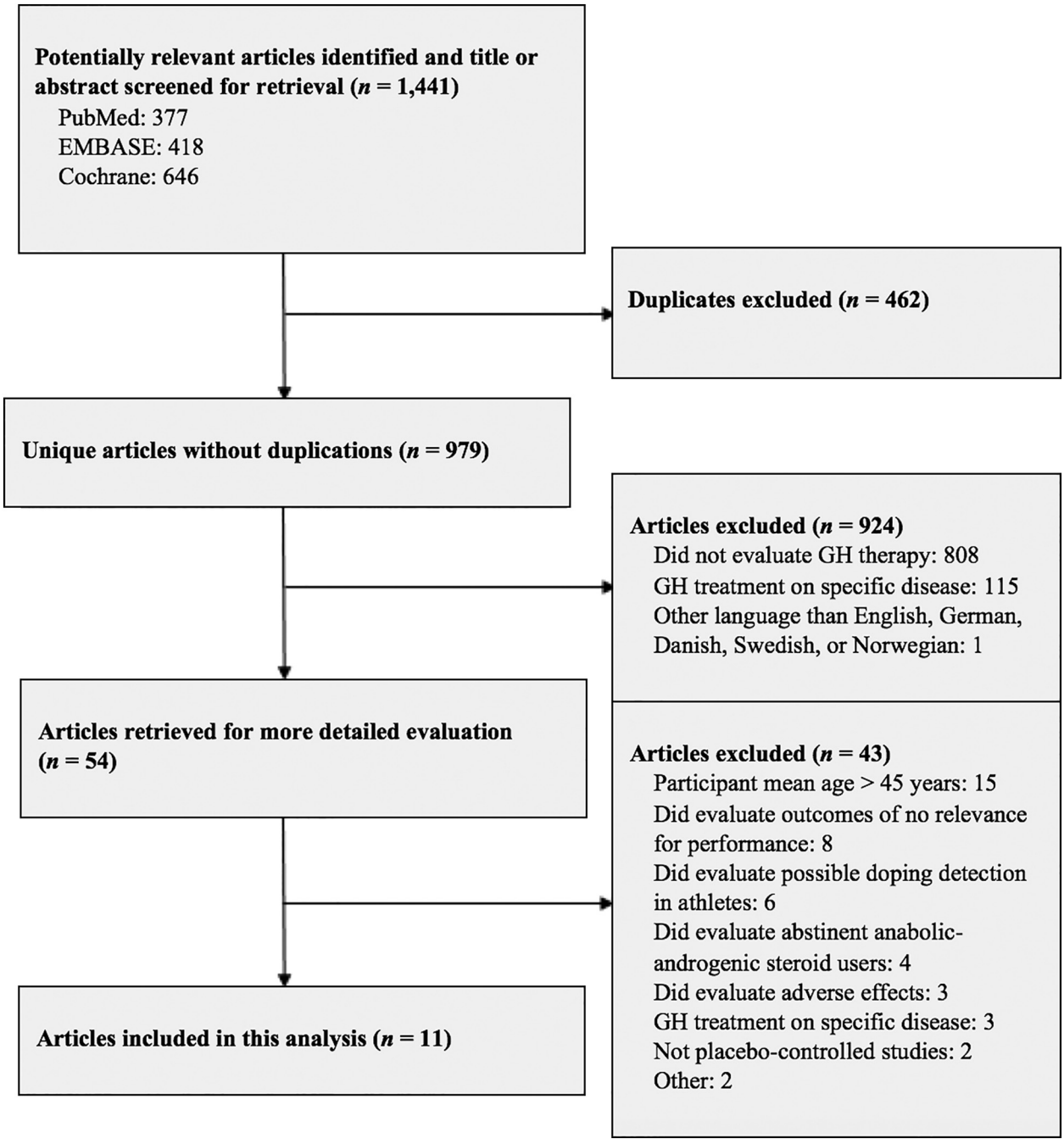

Fig. 1. Flowchart of study selection.

references of relevant articles were also reviewed to identify potentially eligible articles. The literature search and data extraction was performed by one author (K Hermansen). Two other authors (M Bengtsen and JOL Jørgensen) conducted an independent review of the extracted articles, and discrepancies were solved by discussion.

2.2. Inclusion criteria

All randomized, double-blind, placebo-controlled trials of GH administration were included if they provided at least one of the following outcome measures: body composition (e.g. weight, lean body mass, extracellular water, body cell mass, or fat mass), strength (e.g. biceps strength, quadriceps strength, or isometric deadlift strength), indices of lipolysis (e.g. circulating levels of glycerol and/or free fatty acids, or respiratory exchange ratio) or exercise capacity (e.g. lactate levels, bicycling speed, or maximum oxygen uptake). Restriction was applied on participants' age and health status. All participants should be healthy without evidence of pituitary disease. Moreover, studies specifically targeting children, adolescents (< 18 years of age), or older adults (> 45 years of age) were excluded. The terms *lean body mass* and *fat-free mass* are used interchangeably in the literature, why lean body mass and fat-free mass are reported as a single category of lean body mass.

2.3. Data extraction

The following data were extracted from each study: population characteristics (e.g. age, gender, body-mass index, maximum oxygen uptake, and initial IGF-1 levels), study interventions (e.g. dose, route, frequency, and duration of GH administration), study quality (e.g.