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## List of publications

**Jan S. Jeppesen**, Kate A. Wickham, Martin Zeuthen, Martin Thomassen, Søren Jessen, Ylva Hellsten, Morten Hostrup, Jens Bangsbo. *Low-volume speed endurance training with reduced volume improves short-term exercise performance in highly trained cyclists.*

Awaiting response on revision (re-submitted; February 15, 2024, original submission; September 09, 2023) in *Medicine & Science in Sports & Exercise*.

**Jan S. Jeppesen\***, Hannah G. Caldwell\*, Lone O. Lossius, Anna K. Melin, Lasse Gliemann, Jens Bangsbo Ylva Hellsten. *Low energy availability increases immune cell formation of reactive oxygen species to exercise and impairs exercise performance in female endurance athletes.*

Awaiting review (submitted; January 4, 2024) in *Redox Biology*.

Hannah G. Caldwell\*, **Jan S. Jeppesen\***, Lone O. Lossius, Jesper P. Atti, Mikkel Oxfeldt, Mette Hansen, Anna K. Melin, Philip N. Ainslie, Lasse Gliemann, Jens Bangsbo, Ylva Hellsten. *14-days low energy availability in endurance-trained females impairs exercise performance which is unexplained by skeletal muscle mitochondrial respiratory capacity or carbohydrate availability*

In draft for submission in *Journal of Physiology*.

## List of publications not included

**Sommer Jeppesen J**, Vigh-Larsen JF, Oxfeldt MS, Laustsen NM, Mohr M, Bangsbo J, Hostrup M. Four Weeks of Intensified Training Enhances On-Ice Intermittent Exercise Performance and Increases Maximal Oxygen Consumption of Youth National-Team Ice Hockey Players. *Int J Sports Physiol Perform*. 2022 Jul 26;17(10):1507-1515. doi: 10.1123/ijsp.2021-0560. PMID: 35894877.

**Jeppesen JS**, Jessen S, Thomassen M, Backer V, Bangsbo J, Hostrup M. Inhaled beta2 -agonist, formoterol, enhances intense exercise performance, and sprint ability in elite cyclists. *Scand J Med Sci Sports*. 2024 Jan;34(1):e14500. doi: 10.1111/sms.14500. Epub 2023 Oct 25. PMID: 37880916.

Mads Fischer\*, **Jan S. Jeppesen\***, Jeppe F. Vigh-Larsen, Eric J. Stöhr, Magni Mohr, Kate A. Wickham, Lasse Gliemann, Jens Bangsbo Ylva Hellsten, Morten Hostrup. Intensified training augments cardiac function, but not blood volume, in male youth national ice hockey team players. In 2. Revision at *Experimental physiology*.

Oxfeldt M, Marsi D, Christensen PM, Andersen OE, Johansen FT, Bangshaab M, Risikesan J, **Jeppesen JS**, Hellsten Y, Phillips SM, Melin AK, Ørtenblad N, Hansen M. Low Energy Availability Followed by Optimal Energy Availability Does Not Benefit Performance in Trained Females. *Med Sci Sports Exerc*. 2023 Dec 27. doi: 10.1249/MSS.0000000000003370. Epub ahead of print. PMID: 38181220.

Søren Jessen\*, Martin Zeuthen\*, **Jan S. Jeppesen**, Frederik Kehler, Casper Bjerre Olesen, Anders Pallisgaard, Danny Christiansen, Jens Bangsbo, Active ischemic pre-conditioning does not additively improve short-term high-intensity cycling performance when combined with caffeine ingestion in trained young men. *European Journal of Sport Science*, accepted 6<sup>th</sup> February, 2024.

Line Boel Nørregaard; Kate A. Wickham; **Jan S. Jeppesen**; Nicolai Rytter; Laura C. Christoffersen; Lasse Gliemann; Matthew Lawrence; Phillip Adrian Evans; Christina Kruuse. Exercise transiently increases the density of incipient blood clots in antiplatelet-treated lacunar stroke patients. Under review in *Thrombosis Journal*.

**Jeppesen JS**, Breenfeldt Andersen A, Bonne TC, Thomassen M, Sørensen H, Nordsborg NB, Olsen NV, Huertas JR, Bejder J. Immature reticulocytes are sensitive and specific to low-dose erythropoietin treatment at sea level and altitude. *Drug Test Anal*. 2021 Jul;13(7):1331-1340. doi: 10.1002/dta.3031. Epub 2021 Mar 29. PMID: 33739618.

Bonne TC, **Jeppesen JS**, Bejder J, Breenfeldt Andersen A, Olsen NV, Huertas JR, Nordsborg NB. Moderate hypoxic exposure for 4 weeks reduces body fat percentage and increases fat-free mass in trained individuals: a randomized crossover study. *Sleep Breath*. 2023 Aug;27(4):1611-1618. doi: 10.1007/s11325-022-02713-z. Epub 2022 Sep 30. PMID: 36178574.

## Abstract

Competitive athletes continuously strive to improve exercise performance and gain a competitive edge. However, in highly trained athletes, there is a limited room for improvement and therefore, novel strategies to improve performance are crucial. While anaerobic training, such as speed endurance training (SET), is effective in improving short intense performance, when implemented in high volumes, its impact on endurance performance remains less clear. However, as previous studies have commonly utilized a high-volume of SET in each session (>8 bouts), the minimum volume of SET required to achieve an adaptive response is currently unclear. An alternative strategy for athletes is reduction of body weight, which might improve performance through enhancement of power-to-weight ratio. However, while rapid weight loss strategies might improve performance, they carry the risk of posing adverse health effects.

To address these gaps, two studies were conducted investigating the effects of SET (**Study I**) and rapid weight loss (**Study II**) on exercise performance in athletes. **Study I** explored the effects of six weeks of low and high volume SET, while reducing low and moderate training volume, in highly trained male cyclists on short intense and endurance exercise performance and underlying physiological mechanisms. **Study II** investigated the impact of 14 days of low energy availability (LEA) and additionally a three-day refueling period on exercise performance, metabolism, systemic stress, immune function, and inflammation in endurance trained female athletes.

The main findings of this thesis were that **Study I** revealed that implementing a low-volume SET was equally effective in maintaining endurance performance and muscle metabolism as high-volume SET, whereas only the low-volume SET led to improved 4-min time trial performance. **Study II** revealed that female athletes undergoing 14 days of LEA impairs short intense and endurance performance, even when normalized for the reduction in body weight. Moreover, three-days of refueling were insufficient to restore endurance performance but did partly restore short intense performance. Additionally, LEA was associated with increased fat metabolism during rest and exercise and had a profound impact on immune parameters and systemic stress.

Collectively, these two studies provide insights into 1) athletes can benefit from implementing low-volume SET, especially for enhancing short intense and maintain endurance performance during periods of reduced training volume, and 2) the detrimental effects of rapid weight loss and underlying the crucial importance for female athletes to have optimal energy availability for optimizing performance and health.

## Dansk resumé

Konkurrenceatleter stræber konstant efter at forbedre deres præstationsevne. Imidlertid har veltrænede atleter begrænsede muligheder for forbedringer, hvilket gør udviklingen af nye strategier, der kan inducere selv marginale forbedringer i præstationen, afgørende. Mens implementering af anaerob domineret træning, såsom hurtigudholdenhedstræning (SET), i en høj volumen, har vist sig at være effektivt for kortvarig intens præstationsevne, er dens effekt på udholdenhedspræstationen stadig uklar. Da tidligere studier alle har anvendt en høj volumen SET (>8 gentagelser pr. session), er den mindste volumen af SET, der kræves for at forbedre deres præstation, ukendt. En alternativ strategi til intensivering af træning for atleter er at reducere kropsvægten ved at mindske energiindtagelsen og dermed teoretisk forøge power-til-vægt-forholdet. Selvom et hurtigt vægttab potentielt kan påvirke præstationsevnen, er dette ikke velundersøgt, og da det samtidig kan være forbundet med helbreds komplikationer, kræves der mere forskning på området.

Disse strategier blev undersøgt i denne Ph.d.-afhandling i to studier. **Studie I** undersøgte, hvordan veltrænede mandlige atleter responderede på 6 ugers implementering af enten høj eller lav volumen af SET, samtidig med at deres lav og moderatintens træning var reduceret. **Studie II** undersøgte virkningerne af 14-dages lav energitilgængelighed (LEA) og efterfølgende tre dage med tilstrækkeligt energiindtag på præstationsevnen, underliggende fysiologiske mekanismer, systemisk stress, inflammation og immunfunktion hos trænede kvindelige udholdenhedsatleter.

De primære fund i **Studie I** var, at implementering af lav volumen var lige så effektiv til at opretholde udholdenhedspræstationen og muskelmetabolismen som høj volumen SET, hvorimod kun lav volumen inducerede forbedring i kort intens præstationsevnen. I **Studie II** blev det observeret, at 14 dages LEA forringede kort intens og udholdenhedspræstationsevnen, selv når det blev normaliseret til vægttabet. Desuden var tre dages med optimalt energiindtag ikke tilstrækkeligt til at normalisere udholdenhedspræstationen. Derudover var LEA forbundet med øget fedtmetabolisme i hvile og under submaksimalt arbejde, øget systemisk stress og øget oxidativt stress i immunceller efter arbejde.

Denne afhandlings resultater viser, at det kan være fordelagtigt at implementere brugen af SET i den normale træning, især i perioder, hvor træningsvolumen er reduceret, og at der ikke er nogen fordel ved at implementere en høj volumen SET. Ydermere vises det tydeligt, at det er essentielt for kvindelige atleter at indtage tilstrækkeligt med energi, da manglende dette har en stærk negativ indvirkning på præstationsevnen samtidig med, at det har konsekvenser for det generelle helbred.