



Universiteit
Leiden
The Netherlands

The clinical pharmacology of performance enhancement and doping detection in sports

Heuberger, J.

Citation

Heuberger, J. (2019, May 16). *The clinical pharmacology of performance enhancement and doping detection in sports*. Retrieved from <https://hdl.handle.net/1887/73419>

Version: Not Applicable (or Unknown)

License: [Leiden University Non-exclusive license](#)

Downloaded from: <https://hdl.handle.net/1887/73419>

Note: To cite this publication please use the final published version (if applicable).

Cover Page



Universiteit Leiden



The handle <http://hdl.handle.net/1887/73419> holds various files of this Leiden University dissertation.

Author: Heuberger, J.

Title: The clinical pharmacology of performance enhancement and doping detection in sports

Issue Date: 2019-05-16



**THE CLINICAL
PHARMACOLOGY
OF PERFORMANCE
ENHANCEMENT AND
DOPING DETECTION
IN SPORTS**

PROEFSCHRIFT

ter verkrijging van de graad van Doctor
aan de universiteit Leiden, op gezag van
Rector Magnificus prof. mr. C.J.J.M. Stolker,
volgens besluit van het College voor Promoties
te verdedigen op donderdag 16 mei 2019
klokke 11:15 uur

DOOR

Jules Heuberger
geboren te Maastricht in 1989

Design: Caroline de Lint, Voorburg (caro@delint.nl)

All rights reserved. No part from this thesis may be reproduced, distributed or transmitted in any form or by any means, without prior written permission of the author.

Publication of this thesis was financially supported by the foundation Centre for Human Drug Research, Leiden, the Netherlands.

PROMOTOR

Prof. Dr. A.F. Cohen

CO-PROMOTORES

Dr. G.J. Groeneveld

Dr. J.I. Rotmans

LEDEN PROMOTIECOMMISSIE

Prof. Dr. J.M.A. van Gerven

Prof. Dr. C.M. Cobbaert

Dr. J.M.A. Daniels (*Department of Pulmonary Diseases, VU University Medical Centre, Amsterdam*)

Prof. Dr. E.C.M. de Lange (*Research Division of Systems Biomedicine and Pharmacology, LACDR, Leiden*)

Prof. Dr. P.C.W. Hogendoorn

1	INTRODUCTION – 7
2	REVIEW OF WADA PROHIBITED SUBSTANCES: LIMITED EVIDENCE FOR PERFORMANCE-ENHANCING EFFECTS – 15
3	ERYTHROPOIETIN DOPING IN CYCLING: LACK OF EVIDENCE FOR EFFICACY AND A NEGATIVE RISK–BENEFIT – 43
4	EFFECTS OF ERYTHROPOIETIN ON CYCLING PERFORMANCE OF WELL TRAINED CYCLISTS: A DOUBLE-BLIND, RANDOMISED, PLACEBO-CONTROLLED TRIAL – 73
5	REPEATABILITY AND PREDICTIVE VALUE OF LACTATE THRESHOLD CONCEPTS IN ENDURANCE SPORTS – 105
6	ADDITIVE EFFECT OF ERYTHROPOIETIN USE ON EXERCISE-INDUCED ENDOTHELIAL ACTIVATION AND HYPERCOAGULABILITY IN ATHLETES – 127
7	SENSITIVITY AND SPECIFICITY OF DETECTION METHODS FOR ERYTHROPOIETIN DOPING IN CYCLISTS – 147
8	FUTILITY OF CURRENT URINE SALBUTAMOL DOPING CONTROL – 171
9	DISCUSSION AND CONCLUSIONS – 191
	NEDERLANDSE SAMENVATTING – 199
	LIST OF PUBLICATIONS – 205
	CURRICULUM VITAE – 207