

Thermoregulation and Human Performance

Medicine and Sport Science

Vol. 53

Series Editors

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Thermoregulation and Human Performance

Physiological and Biological Aspects

Volume Editor

Frank E. Marino Bathurst

28 figures, and 1 table, 2008

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Medicine and Sport Science

Founder and Editor from 1969 to 1984: E. Jokl[†], Lexington, Ky.

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Library of Congress Cataloging-in-Publication Data

Thermoregulation and human performance : physiological and biological aspects /
volume editor, Frank E. Marino.

p. ; cm. -- (Medicine and sport science, ISSN 0254-5020 ; v. 53)

Includes bibliographical references and indexes.

ISBN 978-3-8055-8648-1 (hard cover : alk. paper)

1. Body temperature--Regulation. 2. Exercise--Physiological aspects. 3.

Heat--Physiological effect. I. Marino, Frank E. II. Series.

[DNLM: 1. Body Temperature Regulation--physiology. 2. Athletic

Performance--physiology. 3. Exercise--physiology. 4. Heat Stress

Disorders--physiopathology. W1 ME649Q v.53 2008 / QT 165 T4112 2008]

QP135.T482 2008

612'.01426--dc22

2008031568

Bibliographic Indices. This publication is listed in bibliographic services, including Current Contents®

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www.karger.com

Printed in Switzerland on acid-free and non-aging paper (ISO 9706) by Reinhardt Druck, Basel

ISSN 0254-5020

ISBN 978-3-8055-8648-1

Contents

vii Preface

Marino, F.E. (Bathurst, NSW)

1 The Evolutionary Basis of Thermoregulation and Exercise Performance

Marino, F.E. (Bathurst, NSW)

14 Comparative Thermoregulation and the Quest for Athletic Supremacy

Marino, F.E. (Bathurst, NSW)

26 Thermoregulation, Fatigue and Exercise Modality

Tucker, R. (Cape Town)

39 Neuromuscular Response to Exercise Heat Stress

Cheung, S.S. (St. Catharines, Ont.)

61 Intestinal Barrier Dysfunction, Endotoxemia, and Gastrointestinal Symptoms: The 'Canary in the Coal Mine' during Exercise-Heat Stress?

Lambert, G.P. (Omaha, Nebr.)

74 Effects of Peripheral Cooling on Characteristics of Local Muscle

Drinkwater, E. (Bathurst, NSW)

89 Cooling Interventions for the Protection and Recovery of Exercise Performance from Exercise-Induced Heat Stress

Duffield, R. (Bathurst, NSW)

104 Ethnicity and Temperature Regulation

Lambert, M.I.; Mann, T. (Newlands); Dugas, J.P. (Chicago, Ill.)

121 Exercise Heat Stress and Metabolism

Mündel, T. (Palmerston North)

130 Author Index

131 Subject Index

Preface

There are many excellent books which examine the relationship between thermoregulation and human performance. The collection of papers in this present book is in no way meant to replace those texts but rather add to the stock of knowledge in this area of human physiology. Over the past century and in particular the last decade, our understanding of the relationship between thermoregulation, performance and fatigue has changed dramatically. For example, early texts on the general subject of muscular exercise gave only a cursory account of the effect of rising body temperature on exercise [1, pp. 28–31]. Nevertheless, the common thread in many seminal texts could be summarized by the statement ‘The ill-effects become more marked as the temperature of the body rises, until they culminate in the disorganization of the bodily functions, which constitute heat-stroke’ [1, p. 31]. However, the majority of research since the seminal work of Pembrey and Nicol [2] shifted to understanding the cardiovascular responses with increasing body temperature because it was noted that cardiovascular strain was indeed increased during times of thermal stress. The development of muscle biopsy techniques and radioactive tracer studies permitted the study of rising and decreasing body temperature on metabolism. Further development of electromyography and electrical stimulation techniques have provided insights into the role the nervous system plays in determining human performance under thermally stressful situations.

Even with the technological and methodological advances, we still do not completely understand why thermal strain induces premature fatigue other than to presume that this is to protect the organism from irreversible cellular damage. This fact alone has necessitated further analysis of previous research in addition to considering theories derived from complimentary areas of research such as evolutionary biology, anthropology and cellular and molecular biology. This book is an

attempt to propose different interpretations of the research which might explain the behavioral and physiological processes which could increase our understanding of the limitations of thermoregulation and in so doing also explain the limits of human performance.

The Earth provides extreme environments with temperature differences ranging from about -80°C at the South Pole to well over 50°C in the Sahara desert. It is not surprising then that temperature has a universal effect on life and that all life processes depend very much on temperature so that the necessary chemical reactions and subsequent biological processes take place when just the right thermal environment is present. However, exercise physiologists have not, as a general rule, considered the evolutionary history of humans as a possible avenue for answers regarding the relationship between thermoregulation and human performance. An attempt has been made by Marino in the first two chapters of this book to turn back the clock and re-discover the foundations of human evolution and the forces which may have shaped our physiology together with a comparison of the thermoregulatory strategies employed by other mammals.

A novel feature of this book is the inclusion of a 'new understanding' of exercise performance which claims that humans, like other mammals, are able to predict the requirements for successful performance in order to make use of the limited physiological capacity. Perhaps the attractiveness of this new school of thought is related to its ability to explain many observations under many different conditions. Tucker, in his paper, provides evidence for an anticipatory exercise response particularly when there is impending thermal strain. The centerpiece of this chapter is the consideration of the self-paced exercise modality which, unlike the fixed-intensity exercise modality, does not mask the individual's physiological response.

The neuromuscular system provides an exciting avenue to explore the effects of thermal strain on human performance. The last decade of research has shown that the central nervous system is deeply affected by increasing body temperature and that there is a distinct reduction in muscle recruitment when this occurs. However, the reasons for this remain elusive. Cheung provides a detailed account of the research in this area and the methodologies by which these observations have been made. Another novel area of research is that of intestinal barrier dysfunction and endotoxemia during times of increasing thermal strain. Lambert proposes that the symptoms associated with this response could possibly provide the organism with a warning signal of impending cellular disruption.

A performance enhancement method which has become increasingly popular amongst athletes is that of body cooling before exercise in order to reduce thermal strain but more recently, the application of cooling for recovery from strenuous physical exercise has been utilized. However, the effects of cooling on local muscle characteristics are seldom considered when these cooling methods are employed. Drinkwater reviews the physiological responses and the various methods utilized

for cooling which could be detrimental to certain modes of exercise. Duffield, in a complimentary paper, provides an analysis of the possible benefits of cooling for thermally stressful conditions in addition to the use of body cooling for protection and recovery from physical exercise.

The morphology of humans is intimately tied to the climate in which various ethnic groups live. There is a notable difference between the athletic performances of certain ethnic groups in given events and therefore the assumption that there is a genetic advantage. Lambert and colleagues provide an in-depth analysis of the various physical characteristics of ethnic groups and the advantages that these characteristics bring in certain environmental conditions. The debate between phenotypic versus genotypic variation is explored.

Finally, the effects of thermal strain on metabolism are considered in the chapter by Mündel. However, this paper considers the consequences of metabolism and the ability for the brain to deal with these consequences rather than concentrate solely on the skeletal muscle requirements during exercise and heat stress.

I would like to acknowledge the very enthusiastic assistance of S. Karger Publishers in the preparation of this edited volume. The merit of this book lies in the work of the authors and I am indebted to them for their efforts and cooperation. Last but not least, my sincere gratitude goes to Professor Tim Noakes for his initial ideas and faith in the Editor!

Frank E. Marino

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