key concepts

Key Concepts in Sport and Exercise Science

DAVID KIRK, CALTON COOKE,
ANNE FLINTOFF & JIM McKENNA

Key Concepts in Sport & Exercise Sciences

Recent volumes include:

Key Concepts in Social Research
Geoff Payne and Judy Payne

Fifty Key Concepts in Gender Studies
Jane Pilcher and Imelda Whelehan

Key Concepts in Medical Sociology
Jonathan Gabe, Mike Bury and Mary Ann Elston

Key Concepts in Leisure Studies
David Harris

Key Concepts in Critical Social Theory
Nick Crossley

Key Concepts in Urban Studies
Mark Gottdiener and Leslie Budd

Key Concepts in Mental Health
David Pilgrim

Key Concepts in Journalism Studies
Bob Franklin, Martin Hamer, Mark Hanna, Marie Kinsey and John Richardson

Key Concepts in Political Communication
Darren G. Lilleker

Key Concepts in Teaching Primary Mathematics
Derek Haylock

Key Concepts in Work
Paul Blyton and Jean Jenkins

Key Concepts in Nursing
Edited by Elizabeth Mason-Whitehead, Annette McIntosh, Ann Bryan, Tom Mason

Key Concepts in Childhood Studies
AlIison James and Adrian James

The SAGE Key Concepts series provides students with accessible and authoritative knowledge of the essential topics in a variety of disciplines. Cross-referenced throughout, the format encourages critical evaluation through understanding. Written by experienced and respected academics, the books are indispensable study aids and guides to comprehension.

DAVID KIRK, CARLTON COOKE,
ANNE FLINTOFF AND JIM MCKENNA

Key Concepts in Sport & Exercise Sciences

SAGE
Los Angeles • London • New Delhi • Singapore

First published 2008

SAGE Publications Ltd
1 Oliver's Yard
55 City Road
London EC1Y 1SP

SAGE Publications Inc.
2455 Teller Road
Thousand Oaks, California 91320

SAGE Publications India Pvt Ltd
B 1/I 1 Mohan Cooperative Industrial Area
Mathura Road, New Delhi 110 044

SAGE Publications Asia-Pacific Pte Ltd
33 Pekin Street #02-01
Far East Square
Singapore 048763

Library of Congress Control Number: 2008922645

British Library Cataloguing in Publication data

A catalogue record for this book is available from the British Library

ISBN 978-1-4129-2227-2
ISBN 978-1-4129-2228-9 (pbk)

Typeset by C&M Digitals (P) Ltd., Chennai, India
Printed in India at Replika Press Pvt. Ltd.
Printed on paper from sustainable resources

The editors dedicate this book to all of the students and staff they have worked with and learned from over many years of teaching sport and exercise sciences.

contents

List of contributors ix
Introduction 1

PART I **3**

Biomechanics **3**
- Introduction 3
- Kinematics 5
- Force 9
- Impacts 12
- Work, Energy and Power 16
- Angular Kinetics 19
- Projectiles 22
- Fluid Mechanics 27

PART II **35**

Exercise Physiology **35**
- Introduction 35
- Nutrition and Biochemistry 37
- Homeostasis 41
- Muscles, Strength and Power 48
- Energy Systems 51
- Energy Balance and Body Composition 54
- Principles of Training 59
- Fitness for Sport and Health 62
- Growth, Maturation, Motor Development and Learning 66

PART III **71**

Pedagogy **71**
- Introduction 71
- Physical Education 73
- Instruction 78
- Learning 81
- Curriculum 85
- Assessment 90

PART IV **95**

Psychology **95**
Introduction 95
Motivation 97
Adherence 100
Physical Activity and Mental Health 103
Immediate Emotional and Affective Responses to Exercise 105
Coping in Sport 109
Expertise 111
Leaders and Leadership 114
Communication 118

PART V **121**

Sociology **121**
Introduction 121
Class 123
Gender 126
'Race' and Ethnicity 130
Disability 134
The Body 137
Identity 140
Globalisation 143

list of contributors

We would like to thank all of the people who have contributed to this book upon the request of the editors; their help and support is greatly appreciated.

Susan Backhouse, Leeds Metropolitan University
Nassos Bissas, Leeds Metropolitan University
Peter Bramham, Leeds Metropolitan University
Ron Butterly, Leeds Metropolitan University
David Carless, Leeds Metropolitan University
Steve Cobley, Leeds Metropolitan University
Carlton Cooke, Leeds Metropolitan University
Chris J. Cushion, Loughborough University
Hayley Fitzgerald, Leeds Metropolitan University
Anne Flintoff, Leeds Metropolitan University
Mike Gray, Leeds Metropolitan University
Brian Hanley, Leeds Metropolitan University
Kevin Hylton, Leeds Metropolitan University
Theocharis Ispoglou, Leeds Metropolitan University
Rod King, Leeds Metropolitan University
David Kirk, Leeds Metropolitan University
Jonathan Long, Leeds Metropolitan University
Christopher Low, Leeds Metropolitan University
Suzanne McGregor, Leeds Metropolitan University
Jim McKenna, Leeds Metropolitan University
Ann MacPhail, University of Limerick
Adam Nicholls, University of Hull
Terry O'Donnell, Leeds Metropolitan University
Toni O'Donovan, Leeds Metropolitan University
Mary O'Flaherty, Mayo Education Centre and University of Limerick
John O'Hara, Leeds Metropolitan University
Andy Pringle, Leeds Metropolitan University
Adrian Schonfeld, Leeds Metropolitan University
Karl Spracklen, Leeds Metropolitan University
Sarah Squires, Leeds Metropolitan University
Louise Sutton, Leeds Metropolitan University
Beccy Watson, Leeds Metropolitan University
Cathy Zanker, Leeds Metropolitan University

Introduction

Over the past 30 years the number of courses in sport, exercise and related topics has grown enormously, making sport currently one of the most popular fields of study in schools, colleges and universities. Many of these courses involve multidisciplinary study of sport and exercise, crossing the biophysical sciences, social and psychological sciences and the humanities. Part of the popularity of courses in sport and exercise is due to the variety that multidisciplinary study provides. But the sheer range and diversity of disciplines involved is also very challenging for students.

Alongside this growth in popularity of school and university courses, research activity has also increased, creating a mini 'knowledge explosion' in sport and exercise. Where once only a few general journals served the sport and exercise research community, now there are usually several journals in each of the specialist areas of study. For students beginning their course of study in sport and exercise, mastering this large and growing body of diverse specialist knowledge can be a bewildering and daunting prospect.

This book seeks to serve as a reader-friendly source of Key Concepts in five of the main areas of study in sport and exercise courses: biomechanics, exercise physiology, pedagogy, psychology and sociology. Each section of the book contains entries on the concepts that organise each of these areas of study. Understanding these concepts is the starting point for understanding sport and exercise more broadly and will allow students beginning their courses to move on to acquire more specialised knowledge. It will also serve as a useful means of preparing for examinations and other forms of assessment for those undertaking more advanced studies who need to refresh their memories.

Each of the entries is concise, explaining in easily accessible language the essential ideas of each of the areas of study in sport and exercise. Serving as a starting point for more advanced study, each entry also offers one or two references for further reading, where each Key Concept is explained in more depth.

So the book is intended primarily for students beginning their college and university courses in sport and exercise sciences, physical education and related topics such as leisure and sport development. It will also provide a valuable and challenging introduction to key ideas for students of A Level physical education and sports studies.

The editors and most of the entry writers are members of academic staff at Leeds Metropolitan University's Carnegie Faculty of Sport and Education. The faculty traces its origins to the Carnegie Physical Training College. Carnegie has been a byword for excellence in sport and physical education since it opened its doors in October 1933. In its 75th year (2008–9), Carnegie is the provider of the most comprehensive range of undergraduate and postgraduate courses in sport and related topics in Britain, including many foundation degrees offered by partner further education colleges in its unique Regional University Network. Supported by colleagues in other well-known institutions for the study of sport, the editors and writers bring all of their research expertise and experience of teaching on these courses to the preparation of this book.

PART I

Biomechanics

INTRODUCTION

Biomechanics is the area of sport and exercise science where the laws, principles and methods of mechanics are applied to the structure and function of the human body. Mechanics can be divided into two categories: statics, which is the study of stationary objects, and dynamics, which is the study of moving objects. Examples of static analysis in sport include standing, different balances in gymnastics and acrobatics and certain resistance exercises where no movement is apparent but large forces may be exerted such as in a scrum in rugby or a closely matched tug-of-war contest. Most activities in physical activity and sport involve movement and therefore require the application of dynamics to understand that movement.

Two other subdivisions are often used to describe different levels of biomechanical analysis: **Kinematics**, which is a description of the movement in terms of time and space, and kinetics, which is concerned with an explanation of the underlying mechanics of the movement and typically involves an assessment of forces. Kinematic analyses in sport typically rely on images recorded by video and other cameras, which can be played back many times either at normal speed or frame by frame, pausing on key frames that show important aspects of the technique. Kinetic analyses in sport and exercise also employ images, but supplement these with force plates and other force transducers, that allow the forces exerted against the ground or on sports equipment to be measured. An example of kinetic analysis related to health is gait analysis, which typically combines ground reaction force data captured as an individual steps on and off a force plate synchronised with frame-by-frame images recorded by a camera. Such an analysis may help a podiatrist to diagnose the cause of problems in walking, where the data collected can assist in prescribing orthotics, which are inserts to go into shoes to help alleviate problems in walking. A typical example from sport would also combine frame-by-frame images synchronised with force measurements, such as the video recording of a kayak paddling stroke, while simultaneously recording the magnitude and direction of the forces exerted on the shaft of the paddle.

The following entries introduce the different components of biomechanics and will help students gain a good understanding of how to analyse movement and learn how to explain how it is produced. The ability to separate good and bad elements of the mechanics of techniques and style is a requirement for all biomechanists who wish to be able to explain how movement patterns in physical activity and sport can be improved.

CARLTON COOKE

Kinematics

Video analysis has become a very popular method to assess sports performance. The recording and repeated observation of motion captured by video cameras is relatively straightforward, especially now that the technology is so readily available and feedback on what has been recorded is immediate via playback through the camera.

However, there are different approaches to motion analysis, which are characterised by the principles and methodology underpinning them. Qualitative analysis (non-numerical and descriptive) is based entirely on visual observation of a movement, sequence of movements or a game performance and it draws its validity from the knowledge and experience of the person who observes and analyses the selected motion. In contrast a quantitative approach (numerical analysis) guarantees objective results as long as the correct mechanical principles and scientific methodology are used. The branch of **Biomechanics** that describes human or object motion mainly via image analysis is called kinematics. Kinematics describes motion in terms of space and time, and it provides valuable information regarding the position and the rate of movement of the human body, its segments or any implement used in a sport and exercise situation.

TYPES OF MOTION AND MECHANICAL QUANTITIES

The pathway of the motion experienced by moving bodies can be described as either straight line (rectilinear motion), or curved line (curvilinear motion) or they can rotate about an axis (*angular motion*). For example, an ice hockey player gliding straight across the ice with the same posture will result in all the segments of his body moving the same distance over the same time period (translation). In addition a discus travelling in the air following a curved path is an example of *linear motion* since its motion is translational too. In contrast, a gymnast who rotates around the high bar with a straight body position undergoes rotation about an external fixed axis where all the body segments travel through the same angle, in the same direction, in the same time, but covering different curvilinear distances with the segments further away from the axis (e.g. feet) travelling further than the segments closer to the axis (e.g. shoulders). There are also occasions where angular motion is observed with respect to an imaginary axis, which in many events could be located outside the physical boundaries of the human body (e.g. rotations in gymnastics or diving about the centre of gravity during flight). However, the most common form of motion in sport and exercise is a combination of angular and linear motion; this is called *general motion*. For instance in cycling, some body segments (e.g. thighs and legs) and parts of the bicycle (wheels) undergo rotation about joints of the body and the centre of the wheel respectively, whereas other body segments (e.g. hips and head) and bicycle parts (e.g. bicycle frame) undergo translation with the total movement of the system (bicycle and cyclist) being linear.

Once the type of motion has been established the kinematic analysis can be performed by applying mechanical principles and formulae that provide information about the changes in the distance covered, the speed of movement and temporal pattern of the movement. In other words, by using vector quantities (magnitude and direction) instead of scalar (magnitude), the *position displacement*, *velocity* and *acceleration* of a body and/or object can be measured and expressed in S.I. units by using the same techniques and formulae for both angular and linear kinematics. The names, symbols and specific units differ between linear and angular quantities to allow inclusion of the characteristics of each type of motion. For example, the definition of velocity is the rate at which a body changes its position with respect to time and it can be obtained if the change in displacement is divided by the time taken for the change in displacement. In linear motion this velocity is denoted by the Latin letter v and it is measured in $m.s^{-1}$. In angular motion it is denoted by the Greek letter ω and it is measured in $rad.s^{-1}$since the change in angular position is represented by the change in angle measured in radians (radians are used because they provide a means of calculating linear velocity of any point rotating around an axis by using the equation $v = \omega r$, where v is linear velocity ($m.s^{-1}$), ω is angular velocity ($rad.s^{-1}$) and r is the radius (m). There are 2π radians in 360°).

ANALYSING MOVEMENT IN PHYSICAL ACTIVITY AND SPORT

One of the main uses of biomechanics in sport and exercise science is in the analysis of patterns of human movement in either physical activity or sport. General movement patterns have common elements in terms of segment movements, axes of rotation and planes of movement and