

Physical Performance Fitness and Diet

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Current concepts regarding the importance of exercise and diet in health and disease, criteria of physical fitness, influence of diet on performance, metabolic responses, and facets of sportsmedicine — including jogging, golf, hiking, bicycling, skiing, and ballet — are all covered in this well-rounded review of research concerning nutrition and physical performance. Chapters also discuss performance and body composition, and growth hormone and insulin mechanisms. Data tables pertaining to stress tests, as well as an extensive bibliography, make this an authoritative and useful reference or textbook.

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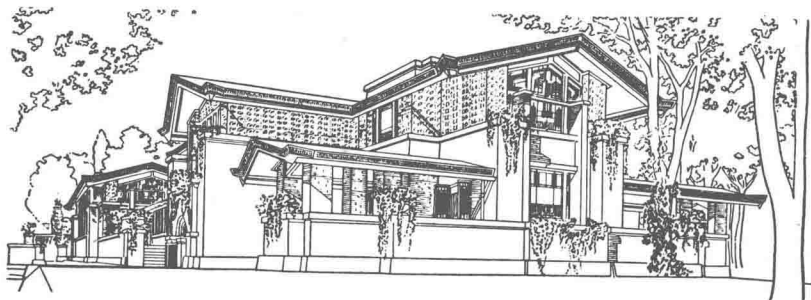


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By

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CHARLES C THOMAS • PUBLISHER
Springfield • Illinois • U.S.A.

Published and Distributed Throughout the World by
CHARLES C THOMAS • PUBLISHER
Bannerstone House
301-327 East Lawrence Avenue, Springfield, Illinois, U.S.A.

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ISBN 0-398-03642-X

Library of Congress Catalog Card Number: 76-56390

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Printed in the United States of America
R-1

Library of Congress Cataloging in Publication Data

Young, Donald R

Physical performance, fitness, and diet.

(American lecture series ; publication no. 1009)

Bibliography: p.

Includes index.

1. Physical fitness--Nutritional aspects. 2. Sports
--Physiological aspects. 3. Work--Physiological
aspects. 4. Obesity--Complications and sequelae.

I. Title. [DNLM: 1. Exertion. 2. Physical fitness.
3. Nutrition. 4. Sport medicine. 5. Deficiency
diseases. WE103 Y69p]

RC1235.Y68 613.7 76-56390

ISBN 0-398-03642-X

**PHYSICAL
PERFORMANCE
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Publication Number 1009
AMERICAN LECTURE SERIES®

A Monograph in
The BANNERSTONE DIVISION of
AMERICAN LECTURES IN ENVIRONMENTAL STUDIES

Edited by
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FOREWORD

THE performance of mankind is determined by interaction of the individual with a host of environmental factors. Among these factors are physical, chemical, social, cultural, and biological components. "Influence is exerted by the various factors or elements as they exist as well as how they are perceived [by man]" (Trumbull, 1965).

Food is one of these environmental factors and its manipulation is one method readily available to improve human health, welfare, and fitness.

Food as an environmental factor for man has been rather widely neglected. It is only within the last few years that the critical role of food and nutrition in the welfare of the human species has become apparent. Extensive researches are now revealing that inadequate nutrition for a mother can wreck havoc on the offspring. Some of the disabilities as the result of inadequate maternal food are temporary. Unfortunately and alarmingly, some of these disabilities are permanent and result in a generation of offspring which are at a disadvantage, not because of their own genetics or actions but because their mother was exposed to a harmful environmental influence in the form of an inadequate diet (Handler, 1970; Dubos, 1968).

Newman (1962) has emphasized the key role of food as an environmental factor: "... nutritional stress in man has very strong ecological and cultural correlates. It should be equally apparent that the nutritional stresses that play such a potent role in human malaise must also impose their stamp on the forms and functions of many aspects of man's culture as well." The day to day ability of the individual human being to carry out, in an effective manner, his assigned tasks in the society in which he happens to live depends in a large part on the quality and the quantity of the food which is available to him. The

interrelationship of food, man, and environment is so close that, although often overlooked, it cannot be denied.

Despite the fact that there is a critical need for a more precise evaluation of food as an environmental factor related to physical fitness and the effectiveness of human performance, Young in this book is forced to point out that "Our knowledge today is based more or less on a data base available in 1958 to 1960." The fact remains that biological scientists are now faced with a challenge to develop a total physiology of work capacity as related to environmental variables. Among these variables which must be given more adequate and more objective consideration is food — the fuel that permits the human machine to operate at all.

The role of food and food elements in the overall welfare of the individual human being is becoming more obvious as the population ages and as various diseases peculiar to older persons begin to assert themselves. For example, the adverse action of cholesterol as an environmental variable is obvious. Whether cholesterol taken into the body as food is poisonous in terms of circulatory health is still a matter of debate.

There does seem to be clear evidence, as an example, that vitamin C, ascorbic acid, is a factor of importance in preventing pathological conditions which can be associated rather directly with a chronic deficiency of vitamin C (Ginter, 1976). It has been found by Ginter, for example, that there is a negative correlation between the amount of vitamin C taken in by a population and the standardized mortality ratios obtained from cerebrovascular disease in different areas of England. Experiments have also demonstrated that vitamin C is remarkable in its capacity to depress the concentration of plasma triglycerides: These blood components seem to play a critical role in the development of atherosclerosis. The studies with ascorbic acid, then, emphasize the necessity for additional detailed experimental and epidemiological studies to ascertain more precisely how ascorbic acid operates in the human body as well as what levels are necessary to insure maximum operating capacity.

The role of exercise in the welfare of the human individual is still a matter of some debate. It certainly seems apparent that

exercise by itself is not the key to life-long physical fitness. Certainly food as an environmental factor, no matter how it is manipulated, by itself cannot insure adequate levels of physical fitness.

Adaptation to caloric deficiency in man is known to occur (Grande, 1964): "The adaptation of the human body to caloric restriction involves the utilization of the body tissues as a source of chemical energy for the metabolism of the body and a reduction in the energy expenditure."

In order to use fat stores and cellular proteins extensively, significant changes in tissue enzyme activity occur as a metabolic adaptation. Secondly, energy expenditure is decreased by several physiological devices: Lowering of basal metabolic rate, decreased cost of physical activity, and lowered specific dynamic action. Most important in lowering the cost of activity is the voluntary reduction of activity (Taylor and Keys, 1950). Dubos (1968) contends that people reared in an environment where nutrition is quantitatively and qualitatively restricted adjust "by living less intensely." The relationship of food restriction with the resulting physiological adaptations to demanding physical performance in man is obscure. Is there a cross adaptation? Young presents information that suggests a potential close interrelationship of fasting, heavy exercise, and human adaptations. This complex problem deserves intensive and imaginative research. Part of the imaginative approach would be to insure more adequate and extensive data collected on the female of *Homo sapiens*.

Young refers to the serum growth hormone; he illustrates this substance with a model which is innovative and which presents material in a form which allows for exciting and new experimental approaches to the challenge of a total physiology of man with respect to significant environmental variables.

Dubos (1965) summarizes the critical role of food as an environmental factor with particular respect to protein deficiency. He says: "Protein deficiency and especially amino acid imbalance are responsible for high death rates among the young, poor physical development in the adults and a chronic illness that persists through life. This form of malnutrition (not neces-

sarily undernutrition) probably constitutes the most important cause of disease in the underprivileged parts of the world."

Young devotes this monograph to the interrelationship of food and physical fitness; it seems appropriate to allude to the belief in the ancient world that diet could modify human behavior. Recent experiments suggest that this ancient belief does have a basis in fact. Ferrets, which ordinarily are rather vicious animals, become tame when fed a soft diet. Human mental activity and the ability to learn are clearly modified by the intake of protein and amino acid. Thus it is that the mental incapacity of children suffering from protein deficiency is so critical. This deficiency slows down mental development and indeed may result in permanent retardation of full mental abilities (Dubos, 1965).

A quarter of a century ago, Mitchel and Edman (1951) pointed out that an evaluation of human nutrition under stressful or nonstressful conditions through the use of experimental animals is no longer justified. There are both qualitative and quantitative differences between the rat (which is used so frequently in experimental biology) and man with respect to nutritional requirements. The extrapolation to man of information obtained on the albino rat is highly questionable. "Under climatic stress, the laboratory animal generally responds so differently, in kind or degree, from the human as to render comparison difficult" (Mitchel and Edman, 1951).

Many of the recommendations made in 1951 by Mitchel and Edman still need further study today. Young has brought out the present state of the art of the interrelationship of nutrition, physical activity, and physical fitness. It is obvious that this aspect of experimental biology of man requires further intensive study.

In all studies of human ecology it must be remembered that human performance is in the final stage based on psychological factors. These factors must be taken into account before one manipulates food in order to improve or change human activity for the better.

Dr. Charles G. Wilber
Editor

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PREFACE

THIS monograph deals principally with the relationships between diet, fitness, and physical work capacity. The extreme nutritional states considered are those associated with acute and chronic food deprivation as well as with obesity. Some attention is given to the effect of supplementation and modification of normal dietaries on work capacity. Within that context, the physiologic basis for dietary formulations is identified, and objective work performance is evaluated in terms of the responses to treadmill exercise or comparable stress tests.

Since the experimental and theoretical basis for providing nutrients for the support of physical work is based somewhat upon the metabolic responses to exercise, attention is given to current concepts regarding the metabolic events associated with work performance and in particular to carbohydrate and fat metabolism and their regulation by hormones. The approach taken has been to review the literature and to delineate the large grey areas where knowledge is incomplete, and also to discuss in some detail selected research studies that either have advanced knowledge or illustrate the breadth of the problems that researchers must address. This review covers principally human studies. Occasional references are made to animal research which have contributed to knowledge of the subject or which bring into sharp focus contrasting species responses.

Fitness and exercise programs for the maintenance of general health status have gained in popularity during the past fifteen to twenty years. This concept is reviewed briefly and some of the difficulties encountered in fitness programs are evaluated from an orthopedic point of view.

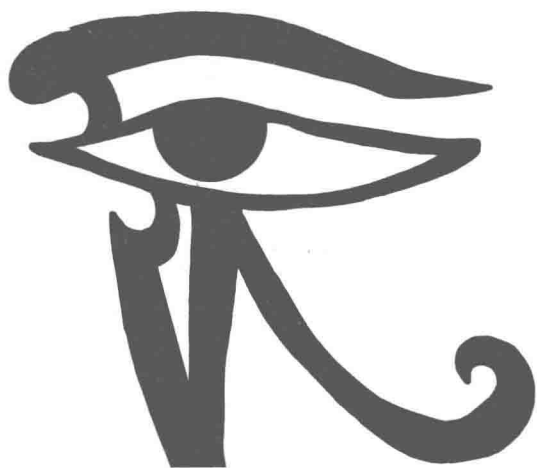
The final portion of the monograph summarizes and draws together the significance of the findings for the understanding of nutrition and performance. Overall, this monograph at-

tempts to demonstrate the interdisciplinary nature of researches on diet, fitness, and performance, and also is an attempt to share with other life scientists and with graduate students the various biological disciplines employed in the studies.

CONTENTS

	<i>Page</i>
<i>Foreword</i>	v
<i>Preface</i>	xi
<i>Chapter</i>	
1. INTRODUCTION	3
2. PERFORMANCE CAPACITY AND NUTRITURE	11
Effect of Food Deprivation	12
Minimum Feeding Concepts	21
Performance and Dietary Supplementation	28
3. PERFORMANCE AND BODY COMPOSITION	50
4. GROWTH HORMONE AND INSULIN MECHANISMS	69
5. SPORTS MEDICINE	86
Jogging	87
Tennis	87
Golf	88
Swimming	89
Hiking	90
Bicycling	90
Skiing	91
Ballet	91
Management	92
Through the Eyes of the Spectator	94
<i>Epilogue</i>	97
<i>Author Index</i>	103
<i>Subject Index</i>	109

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An Egyptian representation of the eye of Horus, the Sun God — sometimes called UDJAT . . . for the ancients it was a symbol of health.

INTRODUCTION

SOME time has elapsed since the critical evaluation of the literature on diet and performance by Keys.¹ That extensive summary reviewed the earlier literature on dietetics and nutritional studies, and evaluated the findings in terms of the dominant concepts relevant to work performance and physical fitness in general. On the basis of Keys' review of in excess of 400 reports which claimed practical effects of various dietary components on performance along with an indication of the theoretical basis, the conclusions that emerge are as follows: (1) Total deprivation of food or water has the most obvious and dramatic effect on performance capacity; (2) for limited periods of time the effect on performance of vitamin, mineral, and general dietary imbalance may be of small consequence; and (3) performance will remain stable during moderate dietary variations, provided that the caloric needs are not too far from being satisfied and that the balance of fats, proteins, and carbohydrates is not too drastically and abruptly altered.

Although the early literature provides a firm data base for the formulation of theory and testing concepts regarding diet and performance, significant improvements in measurement and evaluation techniques, increased awareness as well as greater public health concern have had a major impact on the science of fitness and performance evaluation. Indeed, recent increased public concern for fitness in relationship to health has been expressed extensively through the self-prescription of exercise regimes on the one hand, and the intake of special and in some cases unusual diets on the other hand.

With the realization in the 1950's that cardiovascular disease and obesity were reaching epidemic proportions in the population, new relationships were sought between diet and performance on the one hand, and general health status on the other hand, with the emphasis on therapeutics and the intervention

and prevention of disease. During that period, fewer publications were evident relating specific dietary components to performance and physical fitness or attempting to improve performance capacity through special dietary supplements; the available literature dealt largely with the development of minimum feeding concepts for survival-type situations as well as the nutrition of athletes. However, during that general period, there were significant breakthroughs in methodologies for the measurement of circulating levels of several hormones and also general acceptance and usage of radioisotope techniques for the measurement of lipid and carbohydrate metabolism in man. For the fundamental researcher, those provided the means for detailed investigations of the responses to exercise as well as to diet with the promise of uncovering the myriad of control and regulatory systems associated with body adjustments and altered physiologic states. By the early 1970s certain opinions appeared to emerge from a large and frequently controversial body of data relevant to diet, exercise, and health. Some of these concepts and points of view follow:

With regard to physical fitness achieved through exercise, it was for many years considered axiomatic that general health, leadership qualities, quality and life style, and even longevity were closely associated with a high level of fitness. During the past fifteen years that concept was examined in considerable detail in relationship to ischemic heart disease. Whereas exercise tests are of proven value in the assessment and diagnosis of diseases of the heart, clear scientific data in support of the contention that exercise and physical fitness can prevent myocardial infarction, for example, are meager. Naughton² cites very preliminary evidence suggesting that regular physical activity enhances the survival rate following myocardial infarction. But this author is aware of only one report³ which demonstrates that progressive physical conditioning exercises raise the threshold for and reduce the frequency of premature ventricular complexes induced by physical stress tests. Some of the problems associated with epidemiological studies and controlled exercise trials for the prevention of coronary heart disease were reviewed by Taylor et al.⁴ The sheer magnitude of the