## UNITED STATES OF AMERICA

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Dear Major Thulin:

I wish to congratulate you upon your 80th birthday. You deserve to be honored for your incessant work to create an international organization in physical education which would interchange ideas and materials between the leaders of various nations. The development of the F. I. E. P. bulletin by you and Mr. O. Kragh should be appreciated the world over. While in Europe in 1952, I became amazed at your sincerity and interest in promoting the F. I. E. P. project. It is my observation that all nations will not unite behind any one program called "the Swedish program" or "the American program", but leaders will interchange scientific information with the greatest of pleasure.

There is no professional field so badly in need of scientific information to show the effects produced by the various programs. Most of the research is indirect at best and is typified for restricted conditions in laboratories or limited to animal experiments, wherein the animals lack the motivation, the training and the hereditary background of humans. It gives me the greatest of pleasure to see your organization give encouragement to *direct* findings in which the fitness of people in different programs of physical education is evaluated, the changes that a direct result of certain types of classes are measured, and the physiological and psychological causes determined directly on the humans.

May you continue your good work over many years to come. I wish you the finest returns of all kinds on your 80th birthday as well as for the future. I hope that you do not contemplate giving up the leadership which you have given to the F. I. E. P.

*Thomas K. Cureton, Jr.*

My first meeting with Dr. Thulin was at the 1949 Lingiad, but I had occasion to visit with him later at Illinois when he visited this country.

I cannot recall ever meeting any one person whose devotion to an ideal is so strong. This is particularly meaningful in view of the difficulties one encounters when trying to promote any organization on an international basis where the problems and interests of the countries differ so markedly.

*Richard V. Ganslen*

P. H. Ling will always be remembered because he was the creator of the Swedish system of physical education, a system that, in its ever-developing and ever-improving forms, has influenced physical education around the world through its content, its principles, and through the application of a scientific methodology.

Joseph G. Thulin, present elder statesman of international physical education, a century and a half later goes down in history as that dynamic personality who, functioning as a human catalyzer, did the most to stimulate the development of a truly world-wide federation of physical educators, which federation will, in time, through the international interchange of ideas, through cooperative experimentation and research, and through publications, bring to the peoples of the world tried and proven forms of physical education, best fitted for each of those peoples – forms of physical education that will continue to change, to develop, to advance, and to improve as new thoughts are brought to knowledge by continuing study. As student, teacher, writer, organizer, and as a human engineer of physical education, Joseph G. Thulin is assured of a permanent place in physical education's hall of fame.

*C. H. McCloy*

Institutions have been called the shadows of great men who have brought them into life. F. I. E. P. is the shadow of Thulin but it is more than that. It is an idea that he has shared with many others. He has sweat, tears and blood in every stage of its history to keep it alive; and he has done this with a degree of selflessness that commands our loyalty.

Thulin is a pioneer with conviction. Although he is an "old Swede", he is remarkably young in spirit and flexible in mind. Those of us who saw him in action at Istanbul cannot think of him as a "die hard" for the old just because it is old. He said there that what is modern today is old tomorrow. He has lived long enough to see this happen several times. Thulin wants the best for physical education. He is ready to adapt the new of every generation provided it is also good. This characteristic is one that all of us must learn if we are to be real leaders in a profession. This is the lesson of Thulin. This is F. I. E. P., his shadow.

*·Arthur H. Steinhaus*

## URUGUAY

JULIO J. RODRÍGUEZ
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C'est pour moi un honneur d'adhérer à l'hommage que l'on rend à M. le Professeur Thulin, dans le jour de sa 80ème année, parce que je crois qu'il est un des principaux promoteurs de l'éducation physique dans le monde. Par son profitable travail de professeur, d'écrivain, de conférencier et d'organisateur il a donné une forte poussée aux études de cette éducation dans sa patrie comme à l'étranger. Il est indiscutablement un des professeurs les plus compétents qui ont continué l'œuvre entreprise par Per Henrik Ling, en l'adaptant aux conquêtes modernes de la science, la conduisant à un degré de perfectionnement qui jusqu'à présent n'a pas été surpassé. Grâce à lui, le répertoire des exercices physiques s'est accru des diverses formes utiles dégagées de la vie pratique, sportive comme sociale. Je crois, et mes paroles expriment certainement le sentiment de mon pays, que c'est un juste hommage bien mérité que celui que nous rendons aujourd'hui au plus moderne éducateur de l'âme et du corps humains, le Major Thulin.

*Julio J. Rodríguez*

Dans ce jour où M. le Prof. Major J. G. Thulin atteint sa 80ème année, c'est pour moi un honneur de rendre à travers ces lignes un chaud éloge à un des «leaders» de l'Education Physique mondiale, qui a porté les idées de Ling à un degré d'avancement et progrès parallel au développement de la science moderne, et qui non obstant ses anniversaires, conserve son énergie et ses soins de la jeunesse, toujours au profit de notre spécialité pédagogique.

*José Faravelli Musante*

# BRAZIL[1]

ALFREDO COLOMBO
Dir. of the Ph. Ed. Dept. of Education and Cultural Ministry, Prof. of the Nat. School of Ph. Ed. and Sports, Univ. of Brazil, Rio de Janeiro. – FIEP-Delegate of East Brazil.

With great pleasure we greet Major J. G. Thulin on this festive and enviable date of his 80th birthday.

We don't merely recognize in Major Thulin the physical education professor, but also, especially, the leader who is able to congregate with his valuable personal effort, all the specialized people of the whole world by his enthusiasm, idealism, joy, devotion and perseverance.

Major Thulin deserves from all who know him, the greatest admiration and reverence and his physical and spiritual personality must be pointed out to youth, as an example of what ideals, joy and will are capable of.

*Alfredo Colombo*

[1] Came to hand when the publication was being printed – as to BRAZIL see p. 18.

# ESSAYS

on various aspects of

# Physical Education

by

# *Physical performance and growth*

BY ERLING ASMUSSEN

It was the intention of the founders of F. I. E. P. (earlier F. I. G. L.) that it among other things should act as an intermediary between scientific workers in the field of physical education throughout the world. One way of doing this, as suggested by McCloy (U. S. A.) at the Congress in Istanbul 1953, was for F. I. E. P. to point to problems that could be solved by a sort of international teamwork: In different research centers throughout the world interested persons or groups should tackle the problem and at later occasions, *e. g.* congresses or symposia, the results could be compared and discussed and conclusions be drawn, which eventually could form the basis for further experimental or practical work.

The present writer was one of those who expressed their doubts as to the feasibility of such a plan, for the reason that most research centers are working on a special line, often determined by tradition and earlier works, and presumably would hesitate in having this line broken by work suggested from the outside. It is, therefore, an irony of fate that the present writer so soon should be forced to admit that McCloy's suggestion after all has its merits, by being maybe the first who through F. I. E. P. invites interested colleagues to take part in a joint research problem. It is fortunate that the idea is completely in the spirit of the F.I.E.P. and of our president, Major J. G. Thulin.

The problem that I would like to see attacked on a broad front, is the problem of how physical capacity develops with age in school children of different nationalities and races, living in different climatic and sociological environments.

In a series of investigations performed on 6–700 Danish school children, supplemented by Åstrand's recent investigations on about 200 Swedish children, it appeared, that the results from a series of simple fitness tests were closely correlated to certain anatomic data, as for instance body height, and could be expressed by simple equations of the form: $y = ah^b$ in which y and h are the function and the body height, respectively, and a and b are constants. By assuming geometrical similarity between big and small children – and adequate evidence for the permissibility of this assumption exists – it is possible, theoretically, to predict the values of the exponent, b, in the above equation for a number of functions. By comparing the actually found values of b with the predicted values it was possible to ascertain to which degree the increase with age of the physical performances of the children were simply due to their anatomical growth, *i. e.* to purely quantitative factors, and to which degree a concomitant qualitative development had taken place. A more detailed description of this method and some of the results obtained with it will appear in J. appl. physiol. and, if occasion permits, in F. I. E. P.-Bulletin.

It seems to me that it would be of very great interest if such factors as environment and inheritance could be subjected to an analysis of the same or a similar kind. For the whole problem of physical education in the school age, for evaluations of working efficiency and capacity of different ethnic groups, subjected to different environments etc., it would be of the greatest interest to know if real qualitative differences exist besides the obvious quantitative differences that exist, *e. g.* between a tall and heavy Scandinavian and a small and slender Singhalese.

I take this opportunity – the 8oth birthday of the president of F.I.E.P., major J.G. Thulin – to invite all who might be interested in working on the problems outlined above, to let me have their opinion. In due time a closer description of tests and methods, that all are very simple and straight-forward, can be sent out to those who might wish to participate, and the project can be started.

# *Inhibición de la excreción urinaria durante el esfuerzo*

POR H. CROXATTO

El mecanismo excretor del riñon tan intimamente ligado a la circulación sanguinea, hace depender de las condiciones hemodinámicas imperantes en los glomérulos, el volumen de orina eliminada. Esto justifica plenamente que se hayan realizado importantes y numerosos trabajos destinados a analizar y relacionar las modificaciones de la circulación intrarrenal con la disminución del volumen de orina durante la realización de un esfuerzo muscular. Tanto en el hombre como en las animales de experimentación, el trabajo muscular de cierta intensidad, induce una franca disminución del volumen de sangre que pasa a través del riñon y que coincide con una inhibición de la diuresis. Tendría lugar una vasoconstricción en la arteria aferente, lo que conduciría inevitablemente a una disminución de la presión de ultrafiltración. El tonus de los nervios vasomotores depende de la actividad de centros nerviosos que pueden obedecer a excitaciones de diverso orden, entre los cuales debe considerarse en primer término los de carácter emocional, a los que hay que agregar los efectos de la excitación metabólica, la disminución del $O_2$, el aumento de la tensión del $CO_2$, las pérdidas de agua que se producen por el sudor y la respiración, etc. Sin embargo, desde las clásicas investigaciones de Verney (1946) ha quedado en claro que la exclusión de los nervios vasomotores que van al riñon no impide que el esfuerzo muscular se acompañe de inhibición de la diuresis. En perros especialmente entrenados en los cuales se recogía y medía la orina producida, Verney demostró que la exclusión de esos nervios no frenaban las típicas modificaciones de la diuresis que acompañan al esfuerzo físico. Estos experimentos, si bien no niegan que en las condiciones fisiológicas durante el esfuerzo, los nervios vasomotores intervienen ajustando la circulación renal a las nuevas necesidades de distribución de la sangre, dejan entrever la existencia de otro mecanismo que participaría disminuyendo las pérdidas de agua a traves del riñon. Las propias investigaciones de Verney en el perro, demostraron que durante el ejercicio y por factores emocionales se produciría una descarga de vasopresina, la hormona antidiurética de la neurohipófisis. De una manera inequívoca se demostró la participación de esta glándula porque después de la hipofisectomía, dejó de presentarse la inhibición de la diuresis que acompaña al esfuerzo. Las investigaciones de Fisher y col. (1938) y muchos otros, habían establecido por otra parte, que la actividad de la neurohipófisis depende de la integridad de ciertos nucleos nerviosos situados en el hipotálamo. De este modo nos explicamos que la glándula pueda responder a diversos estímulos entregando vasopresina. Así se explica que cada vez que el organismo se expone a la lucha o se dispone a la defensa, entre en escena la conocida «reacción de alarma» de Selye (1950). Esta compleja reacción de adaptación se acompañaría tambien de una mayor entrega de vasopresina a la sangre y concomitantemente de una disminución de orina. Si bien esta hormona en la concentración que parece circular en la sangre, actuaría principalmente aumentando la reabsorción de agua en los túbulos renales, a ciencia cierta no se sabe si también pueda afectar la circulación de los glomérulos. Estos hechos, por lo tanto, parecen hacer recaer en el mecanismo humoral de la vasopresina la causa más importante de inhibición de la diuresis. Era por cierto importante investigar en el hombre de un modo mas directo, si esta inhibición de la diuresis reconoce como causa determinante una mayor entrega de vasopresina a la circulación. Experimentos realizados en el Laboratorio de Fisiología en el Instituto de Educación Física, en colaboración con Vera (1954), nos han permitido adelantar que en el hombre durante el esfuerzo muscular, aumenta la potencia antidiurética de la sangre. Aun cuando no se ha identificado la o las substancias responsables, presumiblemente la mayor potencia que la sangre adquiere, se debería a una mayor concentración de vasopresina.

Los experimentos fueron realizados en alumnos del Instituto, los cuales se sometieron a un esfuerzo de 30 minutos en el cicloergómetro. En cada sujeto, que estaba en ayunas y que se privaba de fumar desde 12 horas antes, se practicaban una extracción de sangre después de haber permanecido en reposo completo durante media hora. También se recogía la orina producida durante este período. Inmediatemente después se iniciaba un pedaleo en el cicloergómetro de intensidad suficiente para producir una clara excitación respiratoria y circulatoria. Cada uno realizó un trabajo total de 514 Kg/m y en algunos casos se produjo una profusa secreción sudoral. Tan pronto finalizaba la prueba se extraía la segunda muestra de sangre y cada individuo evacuaba de nuevo la vejiga. La potencia antidiurética de ambas muestras de sangre fué determinada en ratas en el test de Burn. Sin retardo de tiempo, con la misma jeringa utilizada para extraer la sangre, se inyectaba por via intraperitoneal 1 ml en 4 ratas que habían sido previamente hiperhidratadas. La comparación de los resultados probó de un modo concluyente, que la sangre obtenida al finalizar el trabajo, poseía un efecto inhibidor sobre la excreción de agua, en las ratas inyectadas, superior al obtenido con la muestra correspondiente al período de reposo. Además se pudo determinar que si los individuos antes de iniciar el trabajo muscular bebían un volumen considerable de agua, se impedía o atenuaba el aumento de la potencia antidiurética que se desarrolla en la sangre por efecto del esfuerzo muscular y como era de esperar, la diuresis fué mayor. Estos resultados se conforman con la sugestión de Verney que la entrega de vasopresina estaría controlada por la presión osmótica del medio interno. Es obvio que la ingestión de agua ejercería una acción contraria a la que induce el esfuerzo muscular mismo.

Experimentos posteriores ensayando las características de la orina recogida durante el período de reposo y la correspondiente al período de trabajo y de restauración, nos revelaron que tambien en la orina se modifica la potencia antidiurética (Croxatto y col. 1954). En efecto, la orina excretada a continuación del esfuerzo se comporta como si contuviese una mayor concentración de substancias antidiuréticas. Aparentemente el organismo se desembaraza a través del riñon, del exceso de hormona que se libera durante el trabajo.

Es evidente que entre los múltiples mecanismos compensadores que se ponen en marcha durante el trabajo muscular de cierta intensidad, debe considerarse como de la mayor significación éstos que tienden a preservar el agua en los tejidos y en los humores. La conservación del agua constituye un imperativo para el cual el organismo organiza todo un sistema defensivo. La unidad hipotálamo-neurohipófisis tiene en este proceso un rol de gran efectividad.

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# *Results of moderate physical training on middle-aged men*

(Combination of land calisthenics and swimming)


BY T. K. CURETON


In typical adult classes for middle-aged men, important gains have been shown in the strength of the heart and circulation, in breath holding ability and in reduction of pulse rates and blood pressures in standard tests at rest and also after a standard exercise; and further, gains have been made in vital capacity and flexibility as well as in back and leg extension strength. The strength of the hands may deteriorate and fat may increase unless intensive swimming is done for considerable periods in cold water and combined with special land exercises, gymnastics or hard endurance activities. Very large gains have been shown in the rhythmic endurance exercises associated with the swimming movements. Several group studies at the University of Illinois Physical Fitness Research Laboratory support these findings.

As an example, an experiment on a group of adult men, in the summer of 1950, at the University of Illinois, ten men (averaging 35.2 years of age, 161.4 lbs., 68.2 ins.) completed the entire measurement and training program over a period of eight weeks. The conditioning work in the pool extended over an average period of six weeks. An instructor led the exercises and directed the pool drills. The subjects were men of ordinary ability from 26 to 55 years of age. The results indicate that the cardiovascular gains are the most important changes induced, with gains from 8 to 24 standard scores. Slight gains are shown in the respiratory tests (vital capacity residuals and breath holding), also in strength, but the men became slightly fatter and their reaction times were definitely slowed.

In this experiment the training caused the pulse rates to decrease 21 standard scores, which is quite usual in endurance work over a period of several weeks. The standing pulse rate improved from 50.30 S. S. to 71.40 S. S., a gain of 21.1 S. S., significant at the 1 % level of confidence. The pulse rate recovery was similarly improved 22 standard scores in the Brouha 5-Min. Step Test, up and down on a 17-inch bench, at 30 steps per min.

The changes in the *Area of the Pulse Wave* (Brachial Wave by Heartometer) changed from 0.38 to 0.61 sq. cm., an average change from 43.71 S. S. to 67.43 S. S., a gain of 23.72 S. S.%. This gain was practically paralleled by the *Systolic Pulse Wave Amplitude* wherein the change was from 1.48 to 1.83 cm., a gain from 57.43 S. S. to 76.00 S. S., or 18.57 S. S.%; also the change in the *Diastolic Pulse Wave Amplitude*, a change from 52.28 to 72.28 S. S., or 20 S. S.%. The interpretation of these changes is that the heart is persistently pumping a larger blood flow in the normal quiet state, consistent with a shift of the autonomic nervous balance toward a mild sympatheticotonia. Such changes are associated with improved endurance.

The changes in the reaction time were of similar trend for all of the three tests: (1) Reaction to Light from an average of 0.226 to 0.357 secs. (2) Reaction to Sound from 0.261 to 0.373 secs. (3) Combined Light and Sound Reaction from 0.226 to 0.313 secs. This slowing up of the reaction times is due to the elimination of fast responses, all of the work being of the slow rhythmic type rather than agility type. The slowing of the reaction times from .226 to .313 secs. on the *Illinois Vertical Jump Reaction Time Test* is consistent with several other experiments which have been completed at the same laboratory. The rather slow, rhythmic type of endurance movement involved in swimming, seems to be part of the cause, as the men never did any sprinting. There is also the action of cold water over fairly long periods of time acting as a nervous depressant.

# *L'analyse du mouvement*

## Son but, son objet

PAR ALBERT GOVAERTS

L'analyse du mouvement est indispensable au professeur d'éducation physique s'il désire comprendre la structure des exercices qu'il utilise et contrôler les effets qu'il leur attribue. P. H. Ling en avait d'ailleurs souligné toute l'importance.

Le problème de l'analyse du mouvement peut se ramener à l'énoncé suivant:

Connaissant les conditions d'exécution d'un geste sportif ou d'un exercice de gymnastique et les moyens dont dispose l'être humain pour l'exécuter, quelles sont les modalités d'utilisation de ces moyens pour obtenir les meilleurs résultats?

En d'autres termes, quels sont les moyens physiologiques et mécaniques dont l'homme dispose pour exécuter un mouvement conçu par sa pensée?

Le problème est complexe et difficile si nous désirons l'aborder, le résoudre avec un esprit conforme à la discipline scientifique. En effet, les mécanismes neuromoteurs qui sont le primum movens du mouvement musculaire échappent encore à nos moyens d'investigation. Peut être dans l'avenir l'électromyographie pourra-t-elle nous aider dans ce domaine?

En attendant nous pouvons envisager l'analyse du mouvement en recherchant les possibilités de solution dans la mécanique.

Cette science nous autorise à décrire les faits observés par des postulats dont on peut vérifier l'exactitude, nous y trouvons des lois particulières, des formules précises susceptibles de comprendre la raison de certaines attitudes et de certains mouvements.

Le raisonnement mécanique se justifie d'autant plus que l'organisme humain s'édifie lui même en créant des structures adaptatives osseuses, articulaires, musculaires avantageuses à l'exécution du mouvement. Leur relevé, leur description est souvent d'un enseignement fécond pour l'analyse du mouvement.

D'autre part, le muscle élabore une force que nous pouvons, par hypothèse, assimiler à une force mécanique puisque nous y retrouvons les mêmes caractéristiques (point d'application, directions, sens). L'intensité de la force musculaire nous échappe puisqu'elle est, en fin de compte, fonction du recrutement des cellules corticales et des neuromyones musculaires.

Nous pouvons toutefois tourner cette difficulté, provisoirement du moins, en exprimant arbitrairement et conventionnellement cette intensité par une grandeur mesurée au moyen d'une unité établie d'après le scoring systém. Nous donnons une cote suivant le rôle plus ou moins important que joue le muscle dans l'exécution du mouvement. Il s'agit donc d'une cote fonctionnelle pour les muscles dont l'intervention est déterminante ou accessoire dans l'exécution du mouvement.

Nous sommes autorisés à utiliser cet artifice par le fait que dans un mouvement le muscle n'intervient jamais seul; il s'associe à d'autres pour réaliser des synergies musculaires (muscles agonistes, antagonistes, fixateurs, directeurs, équilibreurs). C'est pour cette raison que l'analyse du mouvement, est, à notre avis, de l'anatomie fonctionnelle.

Dans le mouvement de l'homme l'action musculaire peut toujours se ramener à un reflexe engendré par des forces extérieures et qui a pour effet de maintenir ou de rétablir l'équilibre de la station droite.

Ces forces extérieures sont la pesanteur appliquée au centre de gravité, l'inertie, la réaction d'appuis, le frottement, la résistance de l'ambiance extérieure (souvent négligeable) etc.

Les forces musculaires sont la contractilité et l'élasticité intervenant différemment s'il s'agit d'une contraction statique ou cinétique et suivant que le muscle croise une ou plusieurs articulations.

Ces forces, nous pouvons les envisager dans le cadre des lois de la statique, de la dynamique, de la cinématique enseignées par la mécanique.

Nous sommes ainsi amenés à examiner comment ces forces se composent, d'y substituer une résultante ou un couple. La solution de ce problème est facilitée par la méthode, utilisée couramment par les ingénieurs, le polygone funiculaire de Varignon.

Nous pouvons aussi décomposer ces forces en leurs composantes (rotation et longitudinale). La situation et la fonction des forces par rapport aux articulations (intervenant comme point fixe) nous permet de retrouver les caractéristiques des leviers, la manière dont ils s'associent, compte tenu de la longueur des bras de leviers, de l'angle réalisé par chacune de ses forces à son point d'application sur l'axe mécanique du segment mobilisé.

L'analyse du mouvement chez l'homme revient ainsi à considérer l'acte moteur en termes mécaniques. Nous disposons alors d'une base objective nous permettant de porter au crible de la critique les attitudes des exercices, les gestes en rejetant les plus fatigants, les plus défavorables au but poursuivi, en acceptant les plus profitables à la structure de l'homme et à sa productivité, en améliorant ceux qui ont été admis empiriquement.

Le but de l'analyse du mouvement se ramène donc à identifier, déterminer l'intervention des facteurs mécaniques, au cours de l'action musculaire pour engendrer la force, la vitesse, l'habilté.

Nous pourrons ainsi en déduire la meilleure façon d'exécuter un travail musculaire avec le meilleur rendement.

# *Functional thickness variations of articular cartilage*

BY BO E. INGELMARK

Since long ago it is known that most of the tissues and organs of the human body change their size and structure in connection with increased or decreased functional intensity. This appears most pronounced in the muscles which have a great capacity for hypertrophying and atrophying.

The atrophy of the articular cartilages in a joint after a rather long period of rest is well-known. But, on the other hand, the hypertrophy of these cartilages seemed to be dubious, because they have no real blood-vessels. Therefore the nutrition must be low. This has also been proved by later investigations. Within the last few years some Swedish scientists (Ekholm, Holmdahl, Ingelmark and Sääf) have been able to prove that articular cartilages in experimental animals increase in thickness in association with training during a long time. This is the case in both growing and full-grown animals (rabbits and guinea-pigs).

One or two weeks after the beginning of the training the relative number and size of the cells increase. After that the intercellular substance begins to increase faster than the cellular component, and within a few months the articular cartilages contain comparatively much more intercellular substance than before the training began. There are good reasons to suppose that this process will give a softening of the cartilages. The incongruences of the surfaces of the joint head and socket can easily be compensated through that. This means that the pressure will be dispersed on a comparatively large surface, by which the pressure per unit of contact surface is kept low even when there is a great load on the joint. This functional adaptation might be considered to be appropriate for the joint function.

Investigations similar to those which have been mentioned for the experimental animals, have not been made on men. The human articular cartilages, however, show great resemblance both concerning their structure and their physical and metabolical character to other mammals. Therefore, there are good reasons speaking for the similarity of the functional adaptation in articular cartilage from men and from the above-mentioned experimental animals.

It has been shown that the articular cartilages in experimental animals as well as in men show another type of functional adaptation, too. This appears very soon. Only a few minutes training of a joint which first has been resting, gives an increase of the thickness of the articular cartilage. After ½ to 1 hour's rest the articular cartilages resume their earlier thickness. Of course this rapid increase in thickness cannot be caused by a production (and a subsequent reduction) of tissue. The only plausible explanation of these cartilage changes is an imbibition and an outflow of fluid, respectively. That it really is so, has been shown by using a special method for observing microscopic sections of cartilage from joints at rest and from joints which just have been trained. In the latter there are for instance much larger cells than in the former. There are two ways in which the fluid can enter the cartilage, both from the synovia in the joint cavity and via the most basal parts of the cartilage facing the bone. The bone layer, on which the cartilage is placed, is perforated and through these perforations medullary cavity tissue is passing up into the basal parts of the articular cartilages. By using radio-active isotopes and by radio-autographic technique it has been proved that a considerable part of the flow of liquid to the articular cartilages occurs on this way. Owing to these observations one can get a good understanding of the way in which the above-mentioned hasty variation in thickness of the articular cartilages occurs. With great probability this increase in thickness at joint training involves the compressibility of the cartilages. This will in the same way as has been mentioned above for a long training period give a good functional status for the joint.

From what is stated above, it is clear that the articular cartilages show two kinds of adaptation after normal training. The one, which begins gradually and requires weeks before it can be established, without doubt, is a real production of new tissues. The other, which occurs in a few minutes and disappears in about one hour, is an inflow of liquid into the cartilage. These two types of adaptation means a change of the physicals of the articular cartilage, causing them to be better suited to support the load to which they will be subjected in association with joint function.

# *The effect of warming-up on athletic performances*

BY PETER V. KARPOVICH AND CREIGHTON J. HALE

Most athletes in the United States practice warming-up before athletic contests. They do this because of a belief that warming-up will improve performance and will reduce any chance for "pulled" muscles or ligaments.

There are two types of warming-up: *formal* and *general*. In a *formal* type, an athlete goes through the motions to be used in the actual contest. For example, if it is for a high jump, he will warm up by jumping; if it is for pitching a ball, he will warm up by pitching. In a general type of warming-up, an athlete exercises most, if not all, of the large muscle groups. Thus he may do squats or he may run, while getting ready for jumping or for playing football. Although running is used also before a running race, this warming-up belongs to the general type rather than to the formal type.

While there is no disagreement regarding the helpfulness of formal warming-up.

questions are frequently raised regarding the value of general warming-up on some occasions.

No one will doubt the importance of warming-up for a man who is shivering and whose limbs are numb from the cold, before he starts to play a piano or a violin, or to jump or even run. But why should an athlete tire himself by warming-up on a warm or hot day? This question becomes especially pertinent because athletes have been known to break records *without* preliminary warming-up.

Experiments conducted by Asmussen and Bøje [1] showed that preliminary muscular work, diathermy and a hot shower increased capacity for riding a bicycle ergometer, while massage, on the other hand, had no beneficial effect. Schmidt [2] found that all the methods used by Asmussen and Bøje, including massage, were beneficial, not only for bicycle riding but also for swimming 50 m. and running 100 m.

This controversy regarding the effect of massage, prompted the present writers to undertake an experimental investigation.

Seven experienced college runners were used. Three types of warming-up were employed: (1) preliminary exercise (10 minutes), (2) massage (10 minutes), (3) light digital stroking (5 minutes). The last method was used as a control, because it involved a possible psychological effect. Immediately after these procedures, subjects ran 440 yards on an outdoor track. Each type of warming-up was repeated on each man from two to three times. The average time after exercise was 56.17 sec.; after massage, 55.84 sec.; and after digital stroking, 56.50. Statistical analysis showed that the differences between these times were not statistically significant, which means that either all three procedures had an equally beneficial effect, or had no effect whatever.

To probe this dilemma further, additional experiments were undertaken. Subjects ran on an indoor track after no warming-up, and after digital stroking. The respective times were: 59.21 and 59.44. The difference was not statistically significant. Thus digital stroking had no effect upon the performance. Since in the first experimental series, the running time after digital stroking was the same as that after massage and exercise we must conclude that the latter two procedures also had no effect upon the speed of running 440 yds. This conclusion was emphasized by the fact that the campus record was broken by a man who ran "cold".

One should not interpret this conclusion as a suggestion for discontinuing warming-up. An athlete will have to depend upon his own judgement while more evidence is being obtained.

Since college athletes are reluctant to run cold because they are afraid of possible injuries, it is difficult to find a sufficiently large number of subjects in one school. For this reason, these investigators are conducting additional experiments and are urging other investigators to do likewise.

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