PSYCHOLOGICAL, NUTRITIONAL AND PHYSICAL STATUS OF OLYMPIC ROAD CYCLISTS

A. JOHNSON, PhD*, P. COLLINS, PhD*, Isabella HIGGINS**, D. HARRINGTON, PhD**, J. CONNOLLY, MPsychSc††
C. DOLPHIN, MSc††, Mary McCREERY, DipDiet and Nutr††, L. BRADY, MB†† and Moira O'BRIEN, FRCPI⁺

*Department of Biochemistry, Royal College of Surgeons in Ireland, Dublin 2

**Department of Statistics, An Foras Taluntais, Dublin 4

††The Irish Foundation for Human Development, St. James's Hospital, Dublin 8

⁺The Olympic Council of Ireland. Department of Anatomy, Royal College of Surgeons in Ireland, Dublin 2

ABSTRACT

Six members of the Irish Olympic Road Cycling Squad underwent a comprehensive medical, nutritional, psychological and biochemical assessment in January 1983. They were given specific medical and dietary recommendations and were reassessed in January 1984 after a period spanning the competitive racing season. The cyclists' diets at both sessions were comparable and generally conformed with recommended daily intakes. Supplementary ingestion was unnecessary to attain recommended daily intakes of vitamins. Serum levels of HDL-cholesterol increased and triglyceride decreased during the period of the study. The squad had characteristics indicating traits of self-sufficiency, toughness and practical mindedness. At the second assessment there was evidence of heightened ambition and competitiveness and an improvement in mood states with reduced ratings for confusion and tension.

Key words: Olympics, Cyclists, Medical, Nutritional, Psychological

INTRODUCTION

As part of the preparation for the 1984 Olympic Games in Los Angeles, a programme was initiated in January 1983 to ensure that athletes representing Ireland would have comprehensive medical, nutritional and psychological advice available to them.

Forty-one members of the Irish Olympic Squad underwent the initial assessment programme in the early months of 1983, at which time a considerable number of medical and nutritional abnormalities were observed. All the athletes were given specific medical and dietary recommendations and reassessments were planned at six-monthly intervals corresponding to winter and summer training schedules.

We report here some preliminary findings on the effects of our programme over a twelve month period on one of the groups of athletes under study. This group comprises members of the Irish Olympic Road Cycling Squad who have recently completed their second winter assessment.

SUBJECTS AND METHODS

Subjects

Informed consent to participate in the study was given by six members of the Olympic Road Cycling Squad in January 1983, prior to the start of the competitive racing season. The average age of the cyclists was 21 years and they had been competing for 4-10 years. They have won National Championships and International Stage Races in Ireland, Britain and mainland Europe. In addition to regular competitions, their weekly training schedules included road cycling which increased in 1983 from approximately 480 km to 640 km.

Methods

The cyclists were examined in January 1983 (session 1) and January 1984 (session 2) at the same time in their training schedules and prior to commencement of the competitive racing season. All assessments were performed in the mornings. Fourteen-hour fasting blood samples were taken by venepuncture for biochemical and haematological analysis. The volunteers then had a light breakfast, were medically examined and had a consultation with the dietician. They were then tested psychologically and assessed for fitness.

Medical Examination

Medical examinations of all the cyclists were carried out with particular emphasis on the musculo-skeletal, cardiovascular and respiratory systems. Medical advice and physiotherapy treatment were available at all times.

Anthropometric measurements recorded included height, weight, biacromial and bitrochanteric widths. The percentage of total body fat was determined according to Durnin and Womersley (1974) using Lange skin-fold calipers. Measurements were taken at four sites: biceps, triceps, subscapular and suprailiac.

Maximum oxygen uptake was predicted at session 1 from the steady-state pulse method of Åstrand and Rodahl (1970) after submaximal upright exercise on a Monark Bicycle Ergometer using the Åstrand-Ryhming normogram (Åstrand and Ryhming, 1954). In session 2, the maximum oxygen uptake was determined directly using an electrically braked bicycle and a Mijnhardt Oxycon 4 which measures the expired air with an infrared CO₂ analyser and a paramagnetic O₂ analyser. Fitness was assessed by these two different methods as a Mijnhardt Oxycon 4 was not available for session 1.

Nutritional Assessment

The six cyclists completed a detailed weighed dietary record for three alternate days, including one day at the weekend, and a questionnaire relating to smoking and drinking habits, drug consumption and vitamin, mineral and food supplements.

The dietary records were coded and analysed using McCance and Widdowson's food composition tables (Paul and Southgate, 1978). This provided estimates of the daily total energy intake, percentage composition of protein, fat and carbohydrate as well as selected vitamins, minerals, fibre and cholesterol.

Correspondence to:

Alan Johnson
Dept. of Biochemistry
Royal College of Surgeons in Ireland
Dublin 2

⁺Present address:

Prof. Moira O'Brien
Dept. of Anatomy
Trinity College
Dublin

Recommended daily intakes were based on UK and USA tables (HSMO, 1979; National Academy of Sciences, 1980). A standard requirement for total energy was not specified as this varied according to individual height, weight, intensity and extent of training. The UK and USA recommended daily intake of calcium was increased from 800 mg to 1,500 mg because of the reported greater requirement for calcium when the intake of protein is high (Linkswiler, 1976).

Each cyclist was recalled and given specific dietary advice to ensure conformity with recommended dietary intakes. The ingestion of vitamin supplements and tonics was prevalent at the time of the first assessment though not included in the quantification of dietary intake. The athletes were advised to refrain from taking supplements.

Psychological Testing

Questionnaires measuring stable personality traits and current psychological functioning were administered. These included: Cattell 16PF personality questionnaire measuring sixteen basic personality dimensions (Cattell et al, 1970); EPI personality inventory measuring the two dimensions of neuroticism and extraversion (Eysenck, 1964); Bortner Type A scale (Bortner, 1969); general health questionnaire (GHQ) measuring breakdown in psychological functioning (Goldberg, 1978); state-trait anxiety inventory (STAI) (Spielberger et al, 1970); profile of mood states (POMS) measuring six dimensions of mood (McNair et al, 1981). The Cattell 16PF was administered at both sessions.

Fasting Blood Lipid Profiles

Fasting blood samples were taken by venepuncture and the serum was removed immediately after clot formation and was left overnight at 4°C prior to analysis.

All lipids and lipid fractions were measured using kits supplied by Boehringer Mannheim GmbH Diagnostica. Triglycerides were measured by a fully enzymatic UV method and cholesterol was measured by a fully enzymatic colorimetric method. High density lipoprotein cholesterol (HDL-cholesterol) was determined following the precipitation of the other lipoproteins by phosphotungstic acid and magnesium ions. All estimations were made according to the manufacturers' instructions. From these values low density lipoprotein cholesterol (LDL-cholesterol) was estimated as described by Friedewald et al (1972).

Apolipoprotein A was quantitated by radial immunodiffusion using Partigen Plates supplied by Behringwerke A.G., Marburg, Federal German Republic.

Statistical Methods and Analysis of Results

All data was computerised on a DEC VAX 11/750 and from this database the dietary and statistical analysis of results were conducted.

Comparison of the different variables between January 1983 and 1984 was carried out using analysis of variance where each individual is a separate replicate. Results are expressed in the tables as means for each year with the standard errors of the means.

RESULTS

Medical Examination

The cyclists were all in excellent general health. Their medical histories revealed that two suffered from exercise-induced asthma and hay fever. The exercise-induced asthma was treated by inhaling sodium cromoglycate 20 min before exercise. Hay fever was treated with mebhydrolin (50 mg, 3 x daily) (Fabahistin Bayer) and sodium cromoglycate nasal drops (Crynacrom Fisons). One had a history of recurrent

sinusitis and was found to have a deviated nasal septum which was corrected surgically. One had severe acne which was successfully treated. Orthotics were prescribed for three cyclists who had pronated feet with positive Clarke's signs. As a group the cyclists had inflexible hamstrings and a flexibility programme was introduced by the Irish Olympic physiotherapist with beneficial results.

Anthropometric and fitness measurements of the cyclists at the two sessions are shown in Table I. Height, weight, percentage body fat and bitrochanteric widths did not change significantly. There was a statistically significant increase in the biacromial widths ($p < 0.07$). The levels of fitness of the cyclists at both sessions, as reflected by maximum VO_2 values, were within acceptable ranges for elite athletes.

TABLE I
Anthropometric and fitness measurements (means $\pm$ S.E.) of the Irish Olympic Road Cyclists (n = 6).

	January 1983	January 1984	S.E.†
Height (cm)	175.60	175.81	0.15
Weight (kg)	71.23	71.47	0.66
% Body Fat	15.00	14.06	0.62
Biacromial width (mm)	433.33	442.17	2.70*
Bitrochanteric width (mm)	315.67	306.17	3.51
Max VO_2 uptake (ml/kg/min)	66.20	66.50	3.10

†Degrees of freedom = 5

*Significantly different ($p < 0.07$)

Nutritional Assessment

First assessment of the average daily intakes of energy, protein, fat, carbohydrate, cholesterol, fibre, calcium, iron, zinc, vitamins A, D and C, thiamine, riboflavin, niacin and folic acid together with the recommended daily intakes are shown in Table II.

TABLE II
Dietary intakes of selected nutrients (means $\pm$ S.E.) of the Irish Olympic Road Cyclists (n = 6).

	January 1983	January 1984	S.E.†	Recommended daily intakes
Total energy intake [MJ] (kcal)	16.3 (3,894)	16.2 (3,869)	0.9 (212)	—
Protein (% of total calorie intake)	13.5	14.7	0.6	10-15
Fat (% of total calorie intake)	32.6	35.8	1.2	30
Carbohydrate (% of total calorie intake)	53.8	49.5	1.4*	55-60
Cholesterol (mg)	576	464	106	—
Fibre (g)	44.5	46.6	3.0	20
Calcium (g)	1.61	1.74	0.12	1.5
Iron (mg)	22.6	24.1	2.4	10
Zinc (mg)	19.5	19.8	1.9	15
Vit. A (μg)	1,992	2,424	755	750
Vit. D (μg)	3.55	4.38	0.53	2.5
Vit. C (mg)	88.4	107.3	7.8	60
Thiamine (mg/1,000 kcal)	0.68	0.72	0.04	0.5
Riboflavin (mg/1,000 kcal)	0.93	0.92	0.05	0.6
Niacin (mg/1,000 kcal)	15.23	16.17	0.31	6.6
Folic acid (μg)	284	349	28	300

†Degrees of freedom = 5

*Significantly different ($p < 0.075$)

One year later, these same parameters were unchanged with the exception of the percentage carbohydrate intake which

had fallen from 53.8% to 49.5% of the total calorific intake ($p < 0.075$). The cyclists' diets conformed closely with the recommended dietary intake and very little adjustment was required. It is evident, however, that apart from folic acid the other vitamins were ingested well in excess of the recommended intakes.

Psychological Testing

At session 1, the mean scores for the 16PF showed little deviation from normative levels of 5.5 except for Factor Q_2 . The mean score on Factor Q_2 (group dependent v. self-sufficient) was 7.5 indicating a higher level of self-sufficiency. The lowest score obtained was 4.5 for both Factor I (tough v. tender-minded) and Factor M (practical v. imaginative).

On the EPI scale for neuroticism, the mean scores obtained at sessions 1 and 2 were 12.8 and 11.7 respectively, and for extraversion the mean scores were 15.7 and 15.5. These differences were not statistically significant. Both neuroticism and extraversion were higher than normative levels.

The Bortner Type A scale showed a significant increase from first to second session (mean 185.2 and 191.7 respectively, $p < 0.02$). Type A is a measure of competitiveness, ambition and aggressiveness, and the significant increase in this measure indicates that the cyclists increased their desire to win.

The GHQ measure of psychological risk did not change on the two observations and was found to be very low, indicating good psychological functioning. There were drops in reported anxiety on both the state and trait components of the STAI, but only the drop in trait anxiety from 41.1 to 34.3 was significant ($p < 0.04$).

The six mood states measured by the POMS, and their changes from session 1 to session 2 are shown in Figure 1. Normative levels for the mood scales range from 10 to 15. The cyclists showed higher than normative levels on vigour and lower on the other scales. This is the 'iceberg' profile of mood states reported elsewhere for the superior athlete (Eysenck et al, 1982). Both tension and confusion decreased significantly from session 1 to 2 ($p < 0.02$).

Fig. 1: Mean scores for the profile of mood states for the Irish Olympic Road Cyclists. *Significantly different ($p < 0.02$).

Blood Lipid Profiles

The fasting blood lipid profiles at the two sessions are shown in Table III. Over the twelve months changes in serum lipids were confined to triglycerides and HDL-cholesterol. There was a significant decrease in triglyceride levels from 1.31 to 0.89 mmol/L ($p < 0.05$) and a significant increase in HDL-cholesterol levels from 0.93 to 1.26 mmol/L ($p < 0.02$). Apolipoprotein A increased slightly but not to a statistically significant extent. By contrast, total serum cholesterol and LDL-cholesterol remained virtually unchanged.

TABLE III
Fasting blood lipid profiles (means $\pm$ S.E.) of the Irish Olympic Road Cyclists ($n = 6$).

	January 1983	January 1984	S.E.†
Triglycerides (mmol/L)	1.31	0.89	0.10*
Cholesterol (mmol/L)	4.50	4.56	0.11
LDL-Cholesterol (mmol/L)	2.98	2.91	0.12
HDL-Cholesterol (mmol/L)	0.93	1.26	0.05**
Apolipoprotein A (g/L)	1.99	2.18	0.14

†Degrees of freedom = 5

*, **Significantly different (* $p < 0.05$, ** $p < 0.02$)

DISCUSSION

This preliminary report of the results of a study on the Irish 1984 Olympic Squad Road Cyclists regarding their medical, nutritional and psychological status in preparation for the Los Angeles games has, even at this early stage, generated interesting findings. The assessments reported were made in January 1983 and 12 months later in 1984, spanning the last full competitive cycling season before the 1984 games. In that time the general medical well-being of the cyclists was confirmed at both assessments. Where minor ailments occurred during the season they were successfully treated and did not intrude significantly on training or competitive schedules.

Of the anthropometric measurements, only the biacromial widths showed any significant change. The cyclists' fitness levels, as assessed by maximum VO_2 uptake, were at levels expected of international athletes and again were not significantly different at the two sessions despite the known limitations of the predictive method (Åstrand and Rodahl, 1970) used in session 1.

The cyclists' diets at both sessions were comparable and generally conformed with recommended daily intakes. The total energy intakes were similar to those reported by Steele (1970) for a group of Australian athletes prior to the 1968 Olympic Games in Mexico but are less than those reported by Strauvenberg et al (1979) for GDR cyclists participating in Montreal, 1976. However, in terms of the percentage composition of the energy intake, the cyclists' relative intake of fat, carbohydrate and protein approximated more closely with those of the GDR competitors. Even in the absence of dietary supplements, the intake of vitamins by the Irish cyclists exceeded recommended dietary allowances. This emphasises the risks associated with unsupervised and indiscriminate ingestion of supplements which may result in hypervitaminosis toxicity.

Total serum cholesterol levels were the same at both sessions despite a reduction of 20% in dietary intake. HDL-cholesterol levels increased during the period of the study consistent with our earlier findings (Brady et al, 1983) and the known association of high HDL-cholesterol levels and exercise (Deshaies and Allard, 1982; Wirth et al, 1979). This study would indicate that the increase in HDL-cholesterol levels is purely an exercise-related phenomenon, as with the cyclists studied here there is no apparent dietary basis for this

considerable change. The finding of an associated increase in apolipoprotein A levels, between the sessions is in accord with the HDL-cholesterol findings, as in man this apolipoprotein is a major component of HDL-cholesterol. Serum triglyceride levels decreased by 32% over the year, again consistent with previous findings on the influence of exercise on triglyceride levels (Wirth et al, 1979).

The psychological evaluation conducted at the two sessions provided clear-cut data regarding the enhanced mental states of all six cyclists. The 16PF evaluation at the first session established the squad with characteristics indicating self-sufficiency, toughness and practical mindedness. The significant increase between sessions in the Bortner Type A analysis provided evidence of heightened ambition and competitiveness acquired over the intervening 12 months. The changes in POMS analyses indicated similar improvement in mood states with a significant reduction in the group score for evaluations on confusion and tension. The GHQ and STAI findings provided corroboration of these results.

These findings, therefore, have established the present physical and mental well-being of these six road cyclists who are due to compete later this year in the Los Angeles games. Their dietary intake over the past year has been monitored and found to be highly appropriate to individuals engaged in strenuous physical activity. The changes observed in their blood lipid patterns and their general psychological testing have indicated training and competition related improvements in their physical and mental states.

We are grateful for financial support from the National Dairy Council of Ireland and the Royal College of Surgeons in Ireland. We wish to thank the cyclists and their coach, Mr. McQuaid, for their diligence and co-operation throughout this study.

References

Astrand, P. O. and Rodahl, K., 1970 "Prediction of maximal oxygen uptake on the basis of heart rate response to submaximal work loads" in *Textbook of Work Physiology* Appendix pp. 617-727. McGraw Hill Book Co. Inc., New York.

- Astrand, P. O. and Ryhming, T., 1954 "A normogram for calculation of aerobic capacity from pulse rate during submaximal exercise". *J.Appl.Physiol.* 7: 218-221.
- Bortner, R. W., 1969 "A short rating scale as a potential measure of Type A behaviour". *J.Chronic Dis.* 22: 87-91.
- Brady, L., Collins, P., Connolly, J., Dolphin, C., Harrington, D., Higgins, L., Johnson, A., McCreery, M. and O'Brien, M., 1983 "A medical, nutritional, biochemical and psychophysiological survey of Irish Olympic Athletes, 1983-1984". *Proc.6th Int.Congr.Food Sci.Tech.* Dublin 3: 113-114.
- Cattell, R., Eber, H. and Tatzucka, M., 1970. *Handbook for the Sixteen Personality Factor Questionnaire*. Institute for Personality and Ability Testing, Champaign, Illinois.
- Deshaies, Y. and Allard, C., 1982 "Serum high-density lipoprotein cholesterol in male and female Olympic athletes". *Med.Sci.Sports Exerc.* 14: 207-211.
- Durnin, J. V. G. A. and Womersley, J., 1974 "Body fat assessed from total body density and its estimation from skinfold thickness". *Br.J.Nutr.* 32: 77-97.
- Eysenck, H. J., 1964. *Manual of the Eysenck Personality Inventory*. Hodder and Stoughton, London.
- Eysenck, H. J., Nias, D. B. K. and Cox, D. N., 1982 "Sport and personality". *Adv.Behav.Res.Ther.* 4: 1-56.
- Friedewald, W. T., Levy, P. I. and Fredrickson, D. S., 1972 "Estimation of low density lipoprotein-cholesterol in plasma without the use of the preparative ultra-centrifuge". *Clin.Chem.* 18: 499-502.
- Goldberg, D., 1978. *Manual of General Health Questionnaire*. NFER Publishing Company, Windsor, Berks., UK.
- HMSO, 1979 "Recommended dietary amounts of food, energy and nutrients for groups of people in the United Kingdom". Report on Health and Social Subjects No. 15, London.
- Linkswiler, H. M., 1976. *Calcium Nutrition Reviews - Present Knowledge in Nutrition* 4th Edition. The Nutrition Foundation Inc., Washington D.C.
- McNair, D. M., Lorr, M. and Droppleman, L. F., 1981. *Manual for Profile of Mood States*. Educational and Industrial Testing Service, San Diego.
- National Academy of Sciences 1980. *Recommended Dietary Allowances* 8th Edition, Washington D.C. 1974, revised 1980.
- Paul, A. A. and Southgate, D. A. T., 1978 in: McCance and Widdowson's *The Composition of Foods*, 4th Edition, HMSO, London.
- Spielberger, C. D., Gorsuch, R. I., Lushene, R. E., 1970. *Manual for the State-Trait Anxiety Inventory*. Consulting Psychologists Press, Palo Alto, California.
- Steele, J. E., 1970 "A nutritional study of Australian Olympic athletes". *Med.J.Aust.* 119:123.
- Strauzenberg, J. E., Schneider, F., Denath, R., Zerbes, H. and Kohler, E., 1979 "The problem of dieting in training and athletic performance". *Bibi.Nutr.Dieta.* 27: 133-142.
- Wirth, A., Schlient, G. and Schettler, G., 1979 "Physical activity and lipid metabolism". *G.Klin.Wochenschr.* 57: 1195-1201.

BOOK REVIEW

Title: TENNIS MEDIC
Authors: Levisohn and Simon
Publishers: (In UK) Blackwell Scientific Publications, Oxford
Price: £14.50 226 pages Figs. Tables ISBN 0-8016-4669-3

This book gives a very comprehensive discourse on all aspects of tennis which must be one of the most popular sports played worldwide.

The first section of the book is devoted to the means by which the body can be conditioned to improve one's play and at the same time prevent injuries. However the average club or county player in this country is unlikely to carry out the many suggestions advised by the authors although the physical fitness fanatic may carry out the exercises with enthusiasm. One point emphasised is the importance of an adequate warming-up period prior to starting play. The usual five minutes knock-up period is insufficient particularly in cold weather. The jogging, sprinting and various other exercises suggested are probably helpful for the professional on the circuit but for most players the way to get fit is to play tennis and keep playing. In the winter months a complimentary game must be found and the best is squash.

The second section of the book deals with tennis injuries but many of those described are so rare they are hardly worth considering. Advice on the management of tennis elbow is disappointing although I appreciate the treatment is most difficult. Changing to a Maxi or Jumbo size racket is of great help not only in preventing but treating tennis elbow. The treatment suggested for most injuries is ice, aspirin and heat but as most injuries get better on their own, I doubt if aspirin is justified as this in itself can have unpleasant consequences in certain individuals.

One important point made is that in hot weather fluid loss must be replaced promptly and the best replacement is water taken in small amounts during changeover even if you are not thirsty.

O. D. Beresford