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# Effects of swimming training on children with asthma

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**Fitch, K. D., Morton, A. R., and Blanksby, B. A. (1976).** *Archives of Disease in Childhood*, **51,** 190. **Effects of swimming training on children with asthma.** In a programme to examine the effect of 5 months of swimming training on schoolchildren with asthma, 46 children swam a total distance of 3608 km (2242 miles) during 2806 training sessions. On post-training re-examination, nonspecific effects of physical conditioning were detected including improved posture and fitness, reduced fat folds, and enhanced swimming ability. Continuous monitoring of asthma and medication showed significant decreases in both parameters during the final phases of the study between children who continued to swim regularly and those who did not.

The frequency and severity of exercise-induced asthma (after running) was unchanged by swimming training. Post-training questionnaires indicated a high degree of enthusiasm and acceptance of the programme by children and parents. No significant adverse effects were observed or reported during the study.

Swimming is a long established and frequent exercise prescription for asthmatic children though the origins of the advice and evidence for its implementation are difficult to find. A comparative study of responses to submaximal running, cycling, and swimming by 40 children and adults who were classified as asthmatic by the definition of the American Thoracic Society (1962), showed that swimming was the least asthmatogenic challenge (Fitch and Morton, 1971). A similar investigation with 10 children agreed with this finding (Anderson, 1972).

Two published reports (Taylor *et al.*, 1968; Chai and Falliers, 1968) noted the response of novice swimmers living in institutions for asthmatics to daily swimming exercise for 6 weeks. The results indicated no adverse effects in the form of increased asthma nor change in pulmonary function, though the authors subjectively considered the children to be much improved.

The object of the present study was to introduce swimming training into the otherwise unaltered lives of asthmatic children and adolescents. To assess the effects of regular swimming, selected medical, physiological, and anthropometric responses were examined throughout the study.

## Methods

**Subjects.** 46 asthmatic schoolchildren aged between 9 years 2 months and 16 years 6 months (mean 12 years 5 months) were studied. The ability to swim 50 m and to attend a suitable pool for regular training were requirements for inclusion. Asthmatics placed in grades C or D of severity for childhood asthma by McNicol and Williams (1973) (Table I) were preferred subjects.

TABLE I

*Severity classification of asthmatic subjects (McNicol and Williams, 1973)*

| Grade | Features | No. of subjects (n = 46) |
|---|---|---|
| A | Not more than 5 attacks of wheeze; late onset and prepubertal cessation of wheeze | 0 |
| B | 5–30 attacks of intermittent wheezing; early reduction of frequency of wheeze and cessation by puberty | 6 |
| C | Early onset of frequent wheeze, mostly intermittent, significant amelioration of asthma by puberty | 27 |
| D | Early onset of wheeze, either very frequent and recurrent, or prolonged episodes of 'chronic asthma' asthma; prevalent during puberty | 13 |

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Each subject started a diary 6 weeks before swimming training began. The amount of wheezing experienced and the medications taken were logged daily, as was the distance swum after the swimming programme was begun. 10 control children of similar age, with no history of asthma or allergic disease, began a similar programme of swimming training.

**Pretraining evaluation.** Before training began, a full medical and exercise history, posture evaluation, and anthropometric measures of height, weight, chest circumference, and chest diameter were recorded. Fat folds were measured with a Harpenden Skinfold Caliper at the triceps, subscapular, abdominal, and suprailiac sites, and the percentage of fat was calculated (Yuhasz, 1962).

In order to compare simultaneously pretraining and post-training levels of physical work capacity with an exercise challenge for exercise-induced asthma (EIA), a submaximal test of 9 minutes of continuous treadmill running was performed. Three increasing work loads, each of 3 minutes' duration, were obtained by increasing the speed and inclination of the treadmill, depending upon the age and fitness of each subject, to achieve a heart-rate of 170–180 beats per minute in the final period. The heart-rates at the completion of each work load were telemetered to an electrocardiogram and were used to estimate an index of physical work capacity at a heart-rate of 170 beats per minute (henceforth $PWC_{170}$) (Wahlund, 1948). This value was predicted by establishing the regression equation for work load against heart-rate by the least squares method. The ventilatory responses of each subject were determined by measuring $FEV_1$ (forced expiratory volume in 1s) and FVC (forced vital capacity) before exercise and 0, 5, 10, 15, 20, and 30 minutes after stopping the test.

**Swimming programme.** Subjects were assigned to a professional swimming coach at a pool conveniently located so as to permit frequent training sessions. Constant liaison was maintained between the 8 coaches at the 8 different pools and the supervising swimming coach. The programme started with three sessions per week, and the intensity, duration, and frequency of training was gradually increased until the weekly goal of five one-hour sessions was reached. Initially the training sought to improve swimming style and was aerobic in nature so as to improve cardiorespiratory endurance. Three separate swimming tests to determine the distance covered in 9 minutes were performed at the completion of the first, third, and fifth months of training.

**Post-training evaluation.** At the completion of the 5-month training programme, subjects were reappraised by the same investigating team under identical test conditions. The detailed questionnaire elicited subjective reactions to the swimming training. A similar post-training treadmill test was used to determine the $PWC_{170}$ and to provide an exercise challenge for EIA. The exercise stress imposed by this test on each subject was modified, if necessary, to allow for any altered level of fitness.

**Treatment of data.** To determine whether any changes occurred as a result of the swimming programme, a two-way analysis of variance with repeated measures on one factor was applied (Winer, 1962). Where significant F ratios were obtained, comparisons were made using the Scheffé technique (Winer, 1962).

## Results

**Swimming groups.** To determine the changes in the various parameters after swimming training at different intensities, the asthmatic subjects were categorized into groups based on the total training distance swum. Those who swam a total of <50 km were classified as group 1 ($n = 14$), those who swam between 50 and 100 km as group 2 ($n = 16$), and those who swam >100 km as group 3 ($n = 16$) (Table II).

TABLE II

*Classification of asthmatic subjects by achieved swimming distance*

| Group no. | No. of subjects | Distance achieved (km) | Mean distance swum (km) | Mean age (yr) (m) |
|---|---|---|---|---|
| 1 | 14 | <50 km | 15·2 | 12 5 |
| 2 | 16 | >50 km<br><100 km | 69·8 | 12 10 |
| 3 | 16 | >100 km | 134·8 | 11 11 |
| All | 46 | | 78·8 | 12 5 |

A $\chi^2$ test indicated that the distribution of the severity of asthma (Table I) did not differ significantly between these swimming groups. The mean improvement in swimming performance of each group after training is shown by the results of the three 9-minute swim tests presented in Fig. 1 (data from group 1 was insufficient for inclusion).

For each parameter both the interaction and, with the exception of the $PWC_{170}$ scores, the difference between groups was not significant. Asthma disability scores consisted of total scores recorded daily for wheeze by day, wheeze by night, cough, or sputum. Significant differences between pretraining and post-training scores for asthma disability (Fig. 2) were recorded. Pretraining and post-training scores for medication (Fig. 3), percentage of fat (Table III), $PWC_{170}$ (Fig. 4), and posture (Table IV) were also significantly different.

Throughout the investigation medication was prescribed by each subject's personal doctor and no

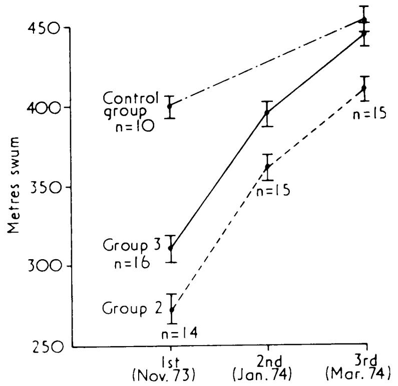


FIG. 1.—*Mean distances swum (+SEM) in metres during each 9-minute swimming test in groups 2 and 3, and nonasthmatic (control) group.*

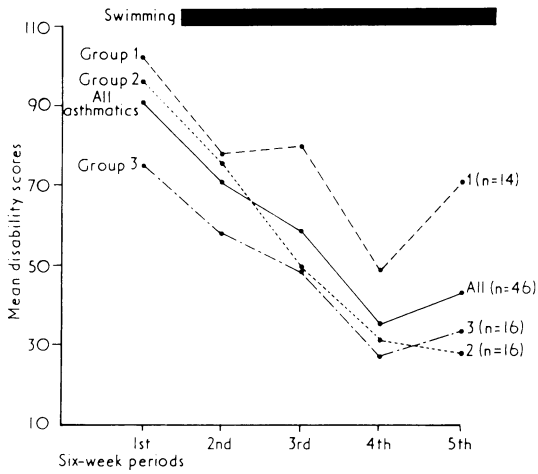


FIG. 2.—*Mean asthma disability scores for each 6-week period in each swimming group.*

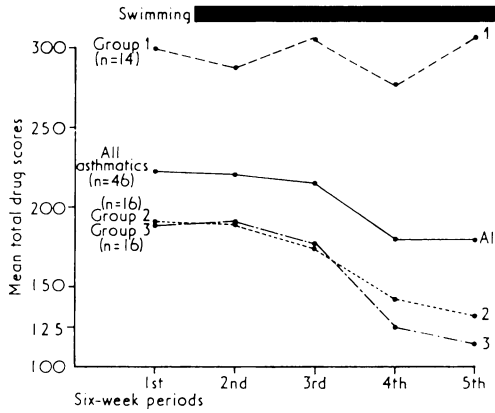


FIG. 3.—*Mean total drug scores for each 6-week period in each swimming group.*

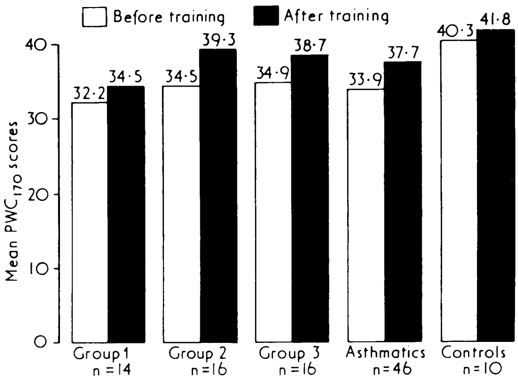


FIG. 4.—*Scores of mean physical work capacity at heart-rate of 170 beats/min ($PWC_{170}$) measured before and after training.*

request to vary the therapy was made. Drug scores, which were calculated by scoring one point for each prescribed dose throughout the 30-week observation period, showed that the mean score was 1018·1 and consisted of (1) sodium cromoglycate BP 378·9, (2) sympathomimetic agents 274·4, (3) methyl xanthines 68·8, (4) corticosteroids 21·5, (5) miscellaneous agents 274·5. Although this parameter was classified as showing no significant

TABLE III

*Differences in mean percentage body fat recorded before (BT) and after (AT) swimming training in asthmatic swimming groups and nonasthmatic subjects*

| Group | n | Mean BT (±SD) | Mean AT (±SD) | % Decrease |
|---|---|---|---|---|
| Swimming group 1 | 14 | 12·60±3·67 | 12·20±3·64 | 3·1 |
| Swimming group 2 | 16 | 11·15±3·10 | 10·30±1·96 | 7·7 |
| Swimming group 3 | 16 | 10·78±2·33 | 10·18±1·97 | 5·8 |
| All asthmatics | 46 | 11·46±3·08 | 10·83±2·69 | 5·5 |
| Nonasthamtics | 10 | 11·55±2·04 | 11·26±2·14 | 2·5 |

TABLE IV

*Mean posture* rating recorded before (BT) and after (AT) swimming training in asthmatic subjects*

| Swimming group | n | Mean posture rating | | | |
|---|---|---|---|---|---|
| | | BT | (SD) | AT | SD |
| 1 | 14 | 38·0 | 4·7 | 42·6 | 4·7 |
| 2 | 16 | 41·0 | 5·6 | 47·3 | 5·6 |
| 3 | 16 | 40·2 | 4·8 | 46·4 | 4·9 |
| All asthmatics | 46 | 39·8 | 5·1 | 45·9 | 5·4 |

*Posture was assessed by means of the New York Department of Education Physical Fitness Test, University of the State of New York, U.S.A.

differences between the groups, the drug scores tended to be training related (P = 0·061). A similar result was obtained for the posture scores where the difference between groups had a probability of 0·067.

The $PWC_{170}$ analysis showed a significant difference between the means of the different swimming groups. The Scheffé test indicated that these significant differences were between swimming groups 1 and 2, and groups 1 and 3.

The nonasthmatic group had a mean pretraining $PWC_{170}$ score that exceeded the mean post-training score of all asthmatic groups. The $PWC_{170}$ score of this group, however, did not change significantly with training.

The degree of EIA which was determined by the maximum percentage reduction of the post-exercise $FEV_1$ showed no significant changes after swimming training. The number of recorded episodes of EIA and the mean maximum reduction of post-exerciseF $EV_1$ for all groups is listed in Table V.

TABLE V

*Incidence of exercise-induced asthma (EIA) and mean maximum percentage reduction of $FEV_1$ before (BT) and after (AT) swimming training in asthmatic swimming groups and nonasthmatic subjects*

| Groups | n | Episodes of EIA | | Mean maximum % reduction of $FEV_1$ | |
|---|---|---|---|---|---|
| | | BT | AT | BT | AT |
| Swimming 1 | 13* | 10 | 12 | 38·5 | 35·3 |
| Swimming 2 | 16 | 12 | 12 | 32·1 | 34·0 |
| Swimming 3 | 16 | 8 | 12 | 29·8 | 27·4 |
| All asthmatics | 45 | 30 | 36 | 33·1 | 32·0 |
| Nonasthmatics | 10 | 0 | 0 | 4·6 | 5·1 |

*The scores of one subject from swimming group 1 were omitted because of an unscheduled preappraisal nebulization with Salbutamol.

**Post-training questionnaires.** Post-training questionnaires were completed by coaches, subjects, and parents, all of whom indicated that training-induced wheeze was an infrequent problem and no subject reported any adverse effect of swimming upon their asthma. Parents were pleased to have been involved in the project, were less protective, and had a better insight into their children's asthma, while the children experienced increased liberties and permission to participate in physical and social activities because of altered parental thinking.

## Discussion

**Asthmatic subjects.** Several parameters showed changes which reflected physiological adjustments due to improved physical condition. These measures included reduction of body fat despite increased body mass, improved posture, greater distances swum in 9 minutes, and increased $PWC_{170}$ scores.

**Asthma and medication.** The mean asthma and mean medication scores declined throughout the study. Though these effects may have been related to seasonal variation of pollen counts and asthma (Fitch, 1974), the decrease seemed to be partially related to training.

**Exercise-induced asthma (EIA).** The absence of any changes after regular swimming training in the post-exercise ventilatory responses of asthmatics to the physical challenge of treadmill running was unrelated to either training volume or asthma severity. EIA persisted despite significant improvements in post-training $PWC_{170}$ scores, medication requirements, asthma scores, and ventilatory volumes exhibited by some subjects. Furthermore, most subjects and parents considered that both asthma and wheezing induced by physical work were reduced at the conclusion of the study.

Two explanations are possible. This response may represent an example of the specificity of training. To test such a hypothesis, it would be necessary to investigate whether regular swimming affected swimming-induced asthma or whether regular running training would modify the ventilatory responses after treadmill running. Alternatively, these results may indicate that exercise testing constitutes a bronchial physical challenge (akin to histamine and methacholine bronchial challenge) to detect bronchial hyper-reactivity.

## Conclusion

On the basis of the results it was apparent that regular swimming training was an eminently suitable method of physical conditioning for children and adolescents with asthma. Significant physical and emotional benefits were achieved in the majority of participants; however, exercise bronchial reactivity was unchanged. Minimal adverse effects were recorded even though the majority of subjects were classified as having moderate or severe asthma.

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