SHORT REPORT

Regular exercise did not modify significantly superoxide dismutase activity in adolescents with Down's syndrome

F J Ordoñez, M Rosety, M Rosety-Rodriguez

Br J Sports Med 2006;**40**:717–718. doi: 10.1136/bjsm.2005.024315

Background: Superoxide dismutase (SOD) overexpression in people with Down's syndrome negatively modifies the equilibrium SOD/glutathione peroxidase+catalase, which may ultimately lead to an increased hydroxyl radical formation.
Objective: To assess the influence of regular exercise on erythrocyte SOD activity to determine the ability of exercise to attenuate increased oxidative damage.
Method: Thirty one male adolescents with Down's syndrome (mean (SD) age 16.3 (1.1) years) performed a 12 week training programme (three days a week), consisting of a warm up, exercise at a work intensity of 60–75% of peak heart rate (the latter calculated from 194.5 – (0.56 × age)), and a cool down period. The reduction of cytochrome *c* at 550 nm was used to monitor SOD activity in the supernatant of erythrocyte haemolysates.
Results: Mean (SD) SOD activity in non-exercised adolescents with Down's syndrome was 679.0 (82) U/g haemoglobin (95% confidence interval 642.2 to 715.8). After the 12 week training programme, it had increased to 706.8 (91) U/g haemoglobin (95% confidence interval 663.9 to 749.8). This increase was not significant (p = 0.099).
Conclusion: Regular exercise did not significantly increase SOD activity and consequently did not affect the unbalanced equilibrium SOD/glutathione peroxidase+catalase observed in patients with Down's syndrome. Further studies are required to assess the behaviour of other antioxidant enzymes included in this pathway in order to highlight potential benefits of regular exercise in redox metabolism of patients with Down's syndrome.

It has been recently reported that regular physical activity may enhance the antioxidant defence system in the general population.[1] However, far less information is available on handicapped people such as those with Down's syndrome. Research on this topic is necessary because oxidative stress has been proposed as a pathogenic mechanism of atherosclerosis, cell aging, carcinogenic events, and immunological disorders in patients with Down's syndrome.[2]

As the superoxide dismutase (SOD) gene is localized to chromosome 21q22.1, it is conceivable that people with Down's syndrome produce an excess of H_2O_2, which may ultimately lead to hydroxyl radical formation and an increase in oxidative damage.[3] Consequently it would be of interest to examine the effect of regular exercise on antioxidant enzymes in general and SOD activity in particular in this population.

For the reasons mentioned above, this study was designed to assess the influence of a 12 week moderate training programme on erythrocyte SOD activity in male adolescents with Down's syndrome to determine the ability of exercise to attenuate the increased oxidative damage associated with this syndrome.

MATERIALS AND METHODS

Thirty one male adolescents with Down's syndrome (mean (SD) age 16.3 (1.1) years) were enrolled. None had current acute medical problems or had taken part in a physical activity programme in the preceding six months. Written informed consent was obtained from their parents. Participants performed a 12 week training programme with three sessions a week. Each session consisted of a 10 minute warm up, followed by an aerobic session at a work intensity of 60–75% of peak heart rate (calculated from the prediction equation $HR_{MAX} = 194.5 - (0.56 \times age)$[4]) lasting 20–35 minutes, increasing by five minutes every three weeks, and then a 10 minute cool down period.

Blood samples were collected from the antecubital vein while participants were at rest three days before and then again three days after the 12 week training programme. Erythrocyte pellets were obtained from 1 ml fasting venous blood by centrifugation at 500 *g* for 10 minutes at room temperature immediately after blood withdrawal. The plasma and buffy layer were then removed, and the erythrocytes were washed three times in 9 g/l NaCl. Erythrocytes were lysed by three freeze-thaw cycles in dry ice and by the addition of five volumes of ice cold distilled water. After centrifugation, the supernatant was frozen at −20°C until determination of enzyme activity. The activity of SOD (EC 1.15.1.1) was determined in the supernatant of the erythrocyte haemolysates. The reduction of cytochrome *c* at 550 nm was used to monitor SOD activity.[5] Enzyme activity was expressed as U/g haemoglobin.

Results are expressed as mean (SD) and 95% confidence intervals. Data were analysed using Student's *t* test for paired data. Significance was established at $p<0.05$.

RESULTS

SOD activity in male adolescents with Down's syndrome was 679.0 (82) (95% confidence interval 642.2 to 715.8) U/g haemoglobin. After a 12 week training programme, the activity had increased to 706.8 (91) (95% confidence interval 663.9 to 749.8) U/g haemoglobin. This increase was not significant (p = 0.099).

DISCUSSION

It is generally accepted that the antioxidant enzyme SOD catalyses the dismutation of the superoxide anion to H_2O_2. Then, in a second step, glutathione peroxidase and catalase convert H_2O_2 into water. Consequently, it is likely that the activities of the antioxidant enzymes in the first and second steps are balanced to prevent oxidative damage.[6]

SOD overexpression in people with Down's syndrome unbalances this equation, which may ultimately lead to increased H_2O_2 production. This indicates that trisomic cells are more sensitive to oxidative stress.[3] We found that a 12 week training programme did not significantly increase erythrocyte SOD activity in adolescents with Down's

syndrome. In contrast, it has been reported that a 16 week training programme increased SOD activity in 16 young male adults with Down's syndrome.[7] Furthermore, we recently found that regular physical activity significantly increased glutathione peroxidase activity and consequently positively modified the above equilibrium (unpublished data).

A review of the literature revealed that the results in the present series (n = 31) are very similar to the highest reported in previous studies on patients with Down's syndrome.[2 8]

We conclude that regular physical activity does not significantly increase SOD activity, indicating that it does not negatively alter the SOD/glutathione peroxidase+catalase balance. Further studies are required to assess the behaviour of other antioxidant enzymes included in this pathway to determine potential benefits of regular exercise on redox metabolism in people with Down's syndrome.

Authors' affiliations
F J Ordoñez, M Rosety, M Rosety-Rodriguez, School of Sport Medicine, University of Cadiz, San Fernando (Cadiz), Spain

Competing interests: none declared

Correspondence to: M R Rodriguez, School of Sport Medicine, University of Cadiz, San Fernando (Cadiz), Spain; manuel.rosetyrodriguez@uca.es

Accepted 19 December 2005

REFERENCES

1 **Franzoni F**, Ghiadoni L, Galetta F, *et al*. Physical activity, plasma antioxidant capacity, and endothelium-dependent vasodilation in young and older men. *Am J Hypertens* 2005;**18**:510–16.
2 **Pastore A**, Tosí G, Gaeta LM, *et al*. Glutathione metabolism and antioxidant enzymes in children with Down syndrome. *J Pediatr* 2003;**142**:583–5.
3 **Kowald A**, Lehrach H, Klipp E. Alternative pathways as mechanism for the negative effects associated with overexpression of superoxide dismutase. *J Theor Biol* 2006;**238**:828–40.
4 **Fernhall B**, McCubbin JA, Pitetti KH. Prediction of maximal heart rate in individuals with mental retardation. *Med Sci Sports Exerc* 2001;**33**:1655–60.
5 **McCord JM**, Fridovich I. Superoxide dismutase. An enzymic function for erythrocuprein (hemocuprein). *J Biol Chem* 1969;**244**:6049–55.
6 **Crosti N**, Bajer J, Gentile M, *et al*. Catalase and glutathione peroxidase activity in cells with trisomy 21. *Clin Genet* 1989;**36**:107–16.
7 **Monteiro CP**, Varela A, Pinto M, *et al*. Effect of an aerobic training on magnesium, trace elements and antioxidant systems in a Down syndrome population. *Magnes Res* 1997;**10**:65–71.
8 **Muchova J**, Sustrova M, Garaiova I, *et al*. Influence of age on activities of antioxidant enzymes and lipid peroxidation products in erythrocytes and neutrophils of Down syndrome patients. *Free Radic Biol Med* 2001;**31**:499–508.