

PHYSIOLOGICAL BENEFITS OF A PROLONGED MODERATE-INTENSITY ENDURANCE TRAINING PROGRAMME IN PATIENTS WITH CORONARY ARTERY DISEASE

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Objectives. To assess the physiological changes that take place in patients with coronary artery disease after 6 and 18 months of moderate-intensity endurance training.

Design. Prospective non-randomised controlled study.

Setting. Johannesburg Cardiac Rehabilitation Centre, a community-based phase III cardiac rehabilitation programme.

Subjects. The 93 patients who completed 18 months of training form the experimental or 'complier' group, while the 18 patients who discontinued the programme form the comparison or 'dropout' group.

Outcome measures. Haemodynamic, electrocardiographic and metabolic measurements at rest and at submaximal and peak exercise levels on admission and after 6 and 18 months of endurance training.

Results. Among the compliers several significant changes took place. Resting heart rate and blood pressure decreased at 6 months ($P < 0.005$). Submaximal heart rate, blood pressure, rate-pressure product and ventilation decreased at 6 months ($P < 0.0001$, $P < 0.01$, $P < 0.001$, $P < 0.01$ respectively), and the rate-pressure product decreased further at 18 months ($P < 0.05$). Ventilatory threshold increased at 6 months ($P < 0.0001$). Peak oxygen uptake, heart rate and ventilation increased at 6 months ($P < 0.0001$, $P < 0.005$ and $P < 0.0001$, respectively), with no further changes at 18 months.

Treadmill time increased at 6 months and again at 18 months ($P < 0.0001$). The only significant change in the dropout group was an increase in ST-segment depression on the exercise ECG from 0.2 to 0.6 mm ($P < 0.05$).

Conclusion. The study confirms that cardiac rehabilitation is beneficial. Most changes occurred in the first 6 months, the longer period of 18 months serving mostly as reinforcement of these and other lifestyle changes.

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The logo for the South African Medical Journal (SAMJ) features the letters 'SAMJ' in a bold, serif font. The letters are rendered with a 3D effect, appearing to be made of a metallic or reflective material, with highlights and shadows that give them depth. The 'S' and 'M' are particularly prominent.



seasons since rugby law changes were introduced specifically to reduce the risk of such injuries in schoolboy rugby players. Indeed, there has been an apparent 23% increase in spinal cord injuries to adult rugby players during this period.

In contrast, there is encouraging evidence that the number of injuries to schoolboy rugby players would seem to have decreased since the previous study (Fig. 1). Where there were 24 schoolboy injuries in the 8 years between 1982 and 1989, in the subsequent 8-year period covered by this study there were 13 such injuries, suggesting a 48% reduction in the number of schoolboy rugby injuries in the Western Cape.

It would seem, therefore, that as many as 11 new injuries may have been prevented by the introduction of rule changes to schoolboy rugby in 1990. These rule changes aimed to reduce the risk of injury in the scrum by reducing the forces at engagement, by 'depowering' the scrum, by preventing wheeling and moving the scrum more than 1.5 m, and by ensuring that only suitably trained players are allowed to scrum in the five tight-forward positions.

Furthermore it would seem that schoolboys suffered less severe injuries than adult players. Sixty-one per cent of schoolboys recovered completely or with only minor disabilities, whereas only 15 of the 53 adults (28%) recovered equally well. This might suggest that the trauma causing these injuries may be less severe in schoolboys than in adults, either because of differences in the nature of the game played by adults and schoolboys, or perhaps as a result of the rule changes introduced in 1990. Alternatively, schoolboys may be more likely to receive ideal early management of these injuries. It is generally believed that the quality of initial management of these injuries can influence the outcome.²

The distribution of the mechanism of injury was similar to that previously reported. Hence 53% of injuries occurred in the tackle phase of the game compared with 50% in the previous study; 25% v. 18% in the ruck and maul and 23% v. 21% in the scrum.

Surprisingly, the recorded proportion of injuries suffered by schoolboy (19%) and adult rugby players (24%) in the scrum was not significantly different, nor were these figures significantly different from the historical proportion (21%). This seems to suggest that the new rules, enacted specifically to reduce scrum injuries, may have been ineffective either because they were not enforced in games in which these injuries occurred or because they failed to address the mechanisms causing these injuries.

Alternatively, the previous report,¹ which did not differentiate the mechanism of injury between schoolboy and adult players, could have missed a higher proportion of scrum-related injuries in schoolboy than in senior rugby players. In that case, the present results would mean a real reduction in scrum-related neck injuries in schoolboys as a result of the law changes. We note, however, that the proportion of scrum-

related injuries remains the same in schoolboys and adults, still accounting for more than 20% of all injuries, which indicates that law changes alone have not solved this problem.

Rather, the fewer spinal cord injuries in schoolboys than adults would seem to be due to a lower proportion (0% v. 32%) of injuries caused by illegal (high) tackles, a consequence that could not have resulted directly from the 1990 rugby law changes.

It follows that if schoolboy injuries are to be further reduced, greater attention must be paid to the prevention of injuries during tackling and the ruck and maul, which together accounted for 81% of the recorded mechanisms of injury in schoolboys.

All injuries to the tackler in both schoolboy and adult rugby resulted from vertex impact and could theoretically have been prevented if the tackler had been taught to tackle using a safe technique.² We have previously reported that inadequate attention is paid to the development of tackling skills at schoolboy level,¹⁵ but the problem clearly still persists at all levels of the game in the Western Cape.

While this study aimed to evaluate the effect of law changes on the number of catastrophic spinal cord injuries in schoolboys, it has also measured the effect of those rule changes on the number of injuries among senior rugby players. Here the results are less sanguine, as the number of these injuries seems to have increased in the past 8 years. This may conceivably have resulted from an increase in the number of senior rugby players in the Western Cape; however the mechanism of injury continues to indicate that the vast majority of these injuries are preventable.

High tackling accounted for 32% of spinal cord injuries in adults (Fig. 2), tackling and scrum collapse for a further 24% each, and the ruck and maul for 20%. Clearly, there is a continuing need to ensure that efforts to protect senior players from injury in these phases of the game should be intensified.

In summary, this study shows an apparent 48% reduction in spinal cord injuries in schoolboy rugby players following the introduction of law changes in 1990. Furthermore, injuries were less severe and 61% of injured schoolboys recovered fully or were left with only minor disabilities following initially paralyzing spinal cord injuries. However there was no evidence that the number of injuries in adult players had fallen during the same period. While this may have been due to an increase in the number of adults playing rugby in this region, the mechanism of injury continues to show that most of these injuries should be preventable.²

Surprisingly, the reduction in the number of schoolboy rugby injuries would seem not to have resulted directly from these specific law changes, as scrum-related injuries were apparently no less common than in the previous study. Rather, there may have been fewer injuries from illegal (high) tackles among

schoolboys, suggesting more strict application of the general rugby rules at schoolboy level since the previous publication.¹

Efforts to reduce the risk of these catastrophic injuries even further will require: (i) a more concerted effort at the senior level of the game including the elimination of high tackling; (ii) efforts to understand and prevent injuries during tackling and the ruck and maul; and (iii) continued vigilance at schoolboy level of the game to ensure that progress made in the past 8 years can be further improved.

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