Boosting in Athletes with High Level Spinal Cord Injury: Incidence, Knowledge and Attitudes of Athletes in Paralympic Sport

Final Report submitted to:

World Anti-Doping Agency

Stock Exchange Tower

800 Place Victoria (Suite 1700)

PO Box 120, Montreal, Canada

30th April 2009

Boosting in Athletes with High Level Spinal Cord Injury: Incidence, Knowledge and Attitudes of Athletes in Paralympic Sport

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Section 1: Executive Summary

Introduction and Purpose

Individuals with spinal cord injuries at or above the sixth thoracic vertebra level (T6 level) can spontaneously experience autonomic dysreflexia. Besides eliciting symptoms such as headache, nausea, dizziness, and blurred vision, it can also induce a significant increase in blood pressure, thereby placing the individual at an increased risk for cerebrovascular and cardiovascular events. Athletes with spinal cord injuries can voluntarily induce autonomic dysreflexia prior to or during the event in order to enhance their performance. The nociceptive stimuli commonly used to induce this reflex are: (i) over-distending the bladder, (ii) sitting on sharp objects, and (iii) use of tight leg straps. This procedure, which is commonly referred to as 'boosting', is usually done one or two hours before the actual event for the reflex to be fully effective. It is postulated that the elevated blood pressure in the dysreflexic condition enhances the cardiovascular and hormonal responses, thereby improving performance.

The World Anti-Doping Agency (WADA) defines doping as any technique that improves performance either by ingesting an external substance or by a method which offers undue advantage. In 1994, the International Paralympic Committee (IPC) deemed boosting to be illegal and banned its practice during competition because research had demonstrated that it was a method that significantly improved performance. Their primary concern was the health and safety of the athlete. Currently, there is no research that has systematically examined the incidence, knowledge and attitudes of competitive athletes pertaining to boosting. The objectives of this research study were to: (1) examine the incidence of boosting in competitive high level spinal cord injured athletes, (2) evaluate their knowledge and beliefs with respect to the effects of boosting on sport performance and overall health, and (3) document their attitudes towards boosting and other performance enhancement strategies in competitive sport.

Research Design

This research study was implemented in four phases. In Phase I, a comprehensive boosting questionnaire designed to evaluate the incidence, knowledge and beliefs, and attitudes towards boosting was developed and validated by the International Paralympic Committee Sport Science Committee (IPCSSC), in conjunction with experts in the field of questionnaire design. In Phase II, a pilot study was conducted to evaluate the questionnaire for content and readability in 15 competitive spinal cord injured athletes. In Phase III, data were collected in three ways: (i) an on-line version of the questionnaire was posted on the IPC website so that athletes could complete this at their convenience; (ii) the questionnaire was sent to members of the International Network for the Advancement of Paralympic Sports through Science (INAPSS) for distribution to eligible athletes, and (iii) during the Paralympic Games in Beijing from 6th to 17th September 2008. In Phase IV, the data were statistically analyzed using the Fisher Exact test to obtain information pertaining to specific questions on the incidence, knowledge and beliefs, and attitudes toward boosting.

Participants

A total of 99 participants completed the questionnaire. Of these 84 were males, 11 were females, and four participants did not identify their gender. In both genders, majority of the participants were in the 34 to 39 year age group (31. 3%), followed by the 28 to 33 yr (23.3%), 16 to 21 yr (20.1%) and 40 to 45 yr (12.1%) age groups. The education level varied considerably amongst the participants. The younger participants had completed some high school education while many of the older ones had attained university undergraduate and post graduate degrees. The injury duration also varied considerably amongst participants and ranged from 1 year to 18 years. A large majority of the participants were involved in wheelchair rugby (54.2%), followed by wheelchair sprint events (10.4%), middle distance racing events and wheelchair basketball (9.4% each), marathon racing, long distance events and throwing events (6.3% each).

Awareness and Incidence of Boosting

Of the 99 participants who completed the survey, 54 (54.5%) had heard of boosting prior to reading about it in the questionnaire, while 39 (39.4%) had not heard of boosting previously. The remaining participants were either unsure (3 or 3%) or did not respond to this question (3 or 3%). There were a significantly greater number of males who had prior knowledge of boosting compared to females. The participants were specifically asked the question: "*Have you ever intentionally induced autonomic dysreflexia to boost your performance in training or competition?*" Of the 60 participants who responded, 10 (16.7%) responded affirmatively while 50 (83.3%) responded negatively. All the positive responses were obtained from the male participants, with the majority competing in wheelchair rugby (55.5%), followed by wheelchair marathon (22.2%) and long distance racing (22.2%). None of the participants involved in wheelchair basketball and throwing events used boosting to enhance performance in training or competition. Approximately two thirds of those who boosted reported that they had never used it: (1) during regular training (64.7%), (2) while training to peak for competition (66%), (3) in national competitions (64%), and (4) in international competitions (62%). A small proportion (6% to 14%) of respondents used it during the two training phases or competitions identified above. Only one participant (2%) indicated that he used boosting all the time during national and international competitions to improve performance.

Knowledge and Beliefs about Boosting

Approximately 41% of the participants felt that boosting was more useful in some sports compared to others, while 15% indicated the opposite. The remaining 44% of the participants were unsure whether boosting was more useful in some sports compared to others. Majority of the participants reported that boosting was most useful in middle distance events (78.6%), long distance events (71.4%), marathon racing (64.3%) and wheelchair rugby (64.3%). This was followed by sprint racing events (57.1%), wheelchair basketball (32.1%), Nordic skiing (21.4%), alpine skiing (10.7%), field throwing (10.7%) and other events (3.6%). Majority of the participants indicated that boosting was most useful during competition (80.5%) when compared to the other phases such as during training (9.8%) or immediately prior to competition (7.3%). The participants identified the following variables that they felt benefited most from boosting during competition: *increased arm strength and endurance, less arm stiffness, less difficulty breathing, improved circulation, less overall fatigue, increased aggression, and increased alertness.* However, a small number of participants also reported *increased anxiety and greater frustration* as possible effects of boosting during competition. Most of the participants agreed that boosting was somewhat dangerous (48.9%) to health. However, 21.3% and 25.5% of the respondents also felt that boosting was dangerous or very dangerous to health respectively. Only a small proportion (4%) of the respondents said that boosting was not at all dangerous. With respect to the symptoms of boosting, most of the respondents identified headache (70.9%), excessive sweating (80.6%), and high blood pressure (83.3%) as the most frequent ones. Shivering (36.8%) and blurred vision (26%) were less frequently reported by the participants. The main source of knowledge regarding the symptoms of boosting was their personal experience (61.7%) and reports from other athletes (50%). The participants gained some information by reading about boosting (22.9%) and received only minimal information (2.1 %) from their coaches. When queried about the consequences of boosting, most of the subjects identified high blood pressure (86%), stroke/cerebral hemorrhage (59.6%), and death (44%) as possible outcomes. Only a small proportion (16.1%) identified seizures as being a possible consequence of boosting.

Attitude towards Boosting

Majority of the participants indicated that boosting was *"completely unacceptable"* for improving training capacity (61.3%), maximizing performance in competition (64.5%), because of knowledge of other competitors were boosting (57.4%), or boosting itself (60.3 %). When queried whether *"boosting should not be banned because it can happen unintentionally"* their opinion was split. Approximately 25% of the participants found this unacceptable while 37% were in agreement with the statement. Similarly, the participants expressed opposing views in responding to the statement *"boosting should not be banned because any athlete with T6 or higher spinal cord injury can decide to induce autonomic dysreflexia."* Approximately 50% of the participants indicated that they currently used other methods to improve performance in training and/or competition which had no associated health risks. Almost 100% of the participants reported that using banned drugs to improve training capacity and maximize performance was unacceptable. These participants also indicated that using banned drugs because their competitors were using them was unacceptable. In responding to the general question "*whether doping was a concern in Paralympic sports,"* 50% of the participants indicated that it was sometimes a concern. This suggests that the decision to boost or no to boost in or order to enhance performance during training and/or competition is an individual one.

Generally speaking, the incidence, knowledge and beliefs, and attitude towards boosting were not influenced by:(1) age, (2) injury level, and (3) injury duration of the participants. However, there was a tendency for the incidence of boosting to be higher in participants with postgraduate degrees compared to those with some high school or post secondary education. These findings should be interpreted with caution due to: (1) the small sample size, particularly in the females, (2) participation primarily from athletes in English speaking countries, and (3) use of self-report questionnaires.

Recommendations

Bearing in mind the study limitations, it is recommended that: (1) educational materials pertaining to boosting be developed in conventional and electronic media to educate the athletes, coaches and trainers about this banned doping method, (2) a concerted effort should be made to target geographical regions where the awareness of boosting is likely to be low and sports in which the likelihood of boosting is high, (3) the frequency of boosting tests at the Paralympic games and other IPC sanctioned events be increased considerably so that the trends in this method of coping can be systematically evaluated, and (4) further research be conducted on a larger number of male and female Paralympic athletes with high level spinal cord injuries in order to increase the generalizability of the study findings.

Section 2: Background and Significance - 'Boosting' Performance in Sport

There is no less contentious issue in elite sport than doping to enhance performance. Athletes are always looking to find the edge over opponents by fair means, or by foul in some cases. Potentially hazardous risks to health through doping are taken in the pursuit of sporting excellence. The increasing profile of sport for athletes with a disability and its potential rewards combined with the frailty of human nature, has led some athletes with disabilities to seek improved performance through the administration of prohibited substances. There is however, a doping method unique to sport for athletes with a disability, which is termed 'boosting'. Boosting is the intentional induction of autonomic dysreflexia (see clinical section below) to enhance performance (Burnham R, Wheeler G, Bhambhani Y, Belanger M, Eriksson P, Steadward R., 1994; Riding M, 2001a; Webborn AD, 1999) and was deemed a prohibited method by the International Paralympic Committee (International Paralympic Committee, 2000) in 1994. But how and why did this practice come about?

The athlete with a high level spinal injury has limited physiological potential for improvements in cardiac output and maximal oxygen uptake which are known to improve racing performance for several reasons. Firstly the loss of sympathetic cardiac innervation results in a maximum heart rate between 110 to 130 beats per minute determined by intrinsic sino-atrial activity (Bhambhani Y, 2003; Bhambhani, 2002; Hoffman, 1986). Secondly, the restricted heart rate reserve and reduced stroke volume are further compounded by a loss of catecholamine response to exercise and by the absence of the muscular venous pump in the lower limbs. These physiological limitations lead some athletes with high level spinal cord injuries to partly compensate for the loss by the induction of the dysreflexic state. But why should athletes intentionally induce such a potentially life-threatening state? During training and competition some athletes had noticed that the dysreflexic state actually reduced the rating of perceived exertion for pushing and faster top speeds were achieved. Although initially the phenomenon was occurring spontaneously, it was found that the condition could be induced by practices including clamping of the urinary catheter to produce bladder distension, excessive tightening of the leg straps, twisting and/or sitting on the scrotum. Athletes felt that in this way they could control the boosted state to command (Webborn AD, 1999).

A research study (Burnham R, Wheeler G, Bhambhani Y, Belanger M, Eriksson P, Steadward R., 1994) of eight athletes using this technique during maximal incremental wheelchair tests and during simulated races confirmed significant performance enhancement with the most striking change being a 9.7% improvement in 7.5 K race performance time. This would be approximately equivalent to reducing the able-bodied marathon record by twelve minutes! In the boosted state at rest there was a lower heart rate and during exercise subjects were able to achieve levels in excess of the normal maximum. Significant rises in noradrenaline levels were seen (7.1 nmol/l boosted v. 2.35 nmol/l 'unboosted') but no change in adrenaline levels occurred. Athletes felt that they were only getting access to a catecholamine response and heart rate reserve that they could normally achieve in exercise if uninjured. However significant rises in blood pressure were observed during the study and the reported ability to control the response was found to be fallacious. Although autonomic dysreflexia can occur spontaneously during exercise (Ashley et al., 1993; Jacobs & Nash, 2004; Schmid et al., 2001), there are no reported incidents of adverse events occurring during exercise. Possibly the cardiovascular fitness of the athlete has a protective effect when compared to the deconditioned patient in a spinal injury unit, but the numbers taking part in elite sport with this level of lesion are relatively small.

The IPC, having deemed boosting to be a prohibited method, have a practical problem with enforcement. Although the concern is for the safety of athletes, there are comparisons with growth hormone abuse – unless you catch the athlete in the act, how do you detect it? Firstly, autonomic dysreflexia occurs spontaneously in athletes with high level spinal cord injuries, and so to prohibit its use it is necessary that there to be a method of not only detecting an athlete in a dysreflexic state, but also proving that the state was intentionally induced. This is difficult to monitor during a race. You cannot ‘pit stop’ athletes for blood pressure checks. Blood pressure measurements were made in the call-up room at the Atlanta Paralympics and other major sanctioned events, and the potential threat was to withdraw athletes with abnormally high readings. The ‘normal value’ of blood pressure in a call-up room before a Paralympic final is difficult to predict, and the IPC might be open to litigation if they withdrew an athlete on these grounds. *The importance of education and dialogue with athletes is the appropriate way in preventing a potential disaster and this task has yet to be addressed by the IPC. For the sports physician, coaches and trainers working with athletes with this disability it is important to be aware of this condition, whether intentionally induced or not.* The immediate management is to remove the nociceptive stimulus where possible and to administer sublingual nifedipine to reduce the blood pressure.

The IPC has a fiduciary responsibility to ensure that athletes compete in a safe manner at the events that are sanctioned by the organization (Riding M, 2001b). *Therefore, it was imperative* *that a study which addresses these issues be conducted, so that the IPC can implement policies that are conducive to their mission.*

Literature and Preliminary Studies

Clinical Autonomic Dysreflexia

Autonomic dysreflexia, as the term suggests, is a reflex syndrome that is unique to individuals with spinal cord injury at lesion levels above T6 (Bloch RF, 1986; Karlsson, 1999). The exact mechanism of autonomic dysreflexia is not completely understood. It is postulated that this response is triggered by nociceptive stimuli distal to the lesion level which result in afferent stimuli that transcend the spinal cord, providing collateral connections to the pre-ganglionic cell bodies of the intermedio-lateral horn, thereby resulting in a massive sympathetic discharge. In individuals with high level spinal cord injuries, the magnitude of the sympathetic discharge is amplified. This is most likely due to: (1) denervation hypersensitivity of sympathetic spinal, ganglionic or peripheral receptor sites, (2) loss of supraspinal inhibitory control, and (3) formation of abnormal synaptic connections resulting from axonal resprouting.

The sympathetic discharge results in peripheral piloerection and vasoconstriction, which is evident in the form of gooseflesh, shivering and pallor distal to the level of injury. As well, there is a large increase in systemic blood pressure. In an attempt to buffer the increase in blood pressure, the aortic and carotid baroreceptors are stimulated, which in turn activate the parasympathetic nervous system proximal to the lesion level. However, the descending impulses originating from the vasodilatory center of the medulla are unable to traverse the spinal cord at the level of the lesion, and therefore, peripheral vasoconstriction and systemic hypertension cannot be regulated in the normal manner. The elevated blood pressure can result in several serious conditions such as cerebral hemorrhage, aphasia, blindness, cardiac arrhythmias and death.

Voluntary Induction of Autonomic Dysreflexia - Boosting

Many athletes with spinal cord injury who compete in competitive sports voluntarily induce autonomic dysreflexia prior to or during the event in order to enhance their performance (Burnham R, Wheeler G, Bhambhani Y, Belanger M, Eriksson P, Steadward R., 1994; Riding M, 2001a). The nociceptive stimuli commonly used to induce this reflex are: (i) overdistending the bladder, (ii) sitting on sharp objects, and (iii) use of tight leg straps. This procedure, which is commonly referred to as *'boosting'*, is usually done one or two hours before the actual event for the reflex to be fully effective. It is postulated that the elevated blood pressure in the dysreflexic condition increases the cardiac output and associated cardiovascular responses, thereby improving performance.

In 1992, the Rick Hansen Center at the University of Alberta conducted a comprehensive study to examine the physiological effects of boosting on simulated 7.5 km wheelchair racing performance. These findings, which addressed the cardiovascular, metabolic and hormonal responses, have been published in several peer-reviewed journals (Burnham R, Wheeler G, Bhambhani Y, Belanger M, Eriksson P, Steadward R., 1994; Wheeler et al., 1994). The results indicated that boosting improved wheelchair racing time by an average of 10% when compared to the control *'unboosted'* condition performed on two separate days. Metabolic measurements indicated that the athletes utilized a greater amount of oxygen during the boosted race. The increased oxygen consumption was not due to an increased in cardiac output, as one might expect as a result of autonomic dysreflexia, but due to enhanced oxygen extraction from the blood as evidenced by the increased $(a - v)O_{2diff}$. Systolic blood pressure was elevated prior to and during the race in the boosted condition, and in some cases reached levels that could be dangerous to the athlete's health No significant alterations were observed in the concentrations of free fatty acids, glucose and blood lactate between the two conditions, although epinephrine levels were elevated in the boosted state. These findings clearly indicate that boosting provides athletes with high level spinal cord injuries with an unfair advantage during distance racing events.

Increasing knowledge of causes and of risk and protective factors in doping behaviour

While there is considerable research on the medical aspects of boosting, research pertaining to the incidence, knowledge and attitudes of athletes towards boosting is lacking. Research in this area will be immensely useful in developing educational programs that can be used by athletes, coaches, trainers and Paralympic sport organizations for increasing the awareness of this illegal practice and improving the safety of the athletes. A computerized literature search indicated that currently there is no scientific peer reviewed literature pertaining to the incidence, knowledge and attitudes of elite spinal cord injured athletes towards boosting. However, a paper published by Raymond (Raymond S., 1994), an international elite wheelchair marathon racer, in the VISTA '93 Conference proceedings (an international conference for researchers, athletes, coaches and trainers in disability sport) suggests that the practice of boosting for both training and competition is rampant in competitive athletes with high level spinal cord injuries. According to

Raymond, competitive athletes routinely discuss the various techniques that they use to initiate boosting and felt that the large improvement in his personal wheelchair racing performance was due to boosting. In his paper, Raymond makes a plea that *"education should be given to athletes about all the aspects of boosting. To permit participation of 'unboosted' athletes, new standards should be fixed to ensure rights for those who do not use boosting."*

Two surveys (Bradbury T, 2001; Chow & Mindock, 1999) have indicated that majority of the elite athletes, particularly those with disabilities, do not have professionally trained coaches. Since a majority of them are self-coached, it is important that scientifically sound relevant information pertaining to boosting is available to these athletes. As well, coaches and trainers who work with athletes with high level spinal cord injuries must be cognizant of this practice and the risks associated with it. However, since the implementation of the IPC boosting policy on 1994, a formal study which examines the incidence, knowledge and attitudes of athletes towards boosting has not been conducted. It is imperative, therefore, that such a comprehensive study be undertaken, so that the IPC could further evaluate its policy pertaining to this method of doping and enable athletes to compete in a safe and equitable environment.

Section 3: Project Objectives

Research Question: The World Anti Doping Agency (WADA) Social Sciences Research Grant Program identified "*Increasing knowledge of causes and of risk and protective factors in doping behaviour"* as a research priority for 2007. A literature search conducted when the grant proposal was submitted and at the time of preparation of this final report indicated that there was no published information pertaining to the incidence, knowledge and beliefs, and attitudes of Paralympic athletes regarding boosting (ie. voluntary induction of autonomic dysreflexia). Therefore, the current research project was designed to: (1) develop and validate a comprehensive boosting questionnaire to provide such information, and (2) evaluate these aspects of boosting in male and female Paralympic wheelchair athletes with spinal cord injuries at or above the T6 level. Several questions pertaining to these three main themes were developed and are included in *Appendix A.*

Research Hypotheses: This study tested the following hypotheses: (1) a significant proportion of the wheelchair athletes with spinal cord lesion levels above T6 will indicate that they used boosting to enhance their physical performance during training and/or competition, (2) there would be no significant difference between males and females in the incidence of boosting, (3) athletes of both genders would demonstrate awareness of the signs and symptoms regarding boosting, and (4) majority of the athletes would find boosting to be unacceptable for improving performance during training and/or competition.

Section 4: Research Design

This study was implemented over a two year period from March 2007 to February 2009. In accordance with the Declaration of Helsinki, ethics approval *(Appendix B)* was obtained from the Health Research Ethics Board (Panel B) at the University of Alberta prior to initiating the study. The experimental design used to complete this study is illustrated below.

Project Period: March 2007 to February 2009

Phase I: Validation	Phase II: Pilot Study	Phase III Data Collection	Phase IV Data Analysis	Phase V Final Report
U of A U of M IPCSSC	Selected Paralympic Centres	INAPSS Beijing 2008 IPC: On-line	RRC @ U of A	IPCSSC
March to December 2007	January to February 2008	March to November 2008	December 2008 to January 2009	February to April 2009

Legend: U of A = University of Alberta; U of M = University of Manitoba; IPCSSC = International Paralympic Committee Sport Science Committee; INAPPS = International Network for the Advancement of Paralympic Sport through Science; RRC = Rehabilitation Research Center.

Phase I - Validation: During this nine month phase (March to December 2007), the boosting questionnaire originally published by Burnham et al. (Burnham R. Wheeler G, Bhambhani Y, Belanger M, Eriksson P, Steadward R., 1994) was used as a starting point for developing a comprehensive questionnaire to evaluate the incidence, knowledge and beliefs, and attitudes of athletes towards boosting. Several questions related to these three themes were added to the questionnaire and subsequently validated by experts in the area of questionnaire design. Initially, the questionnaire was reviewed by two experts from the University of Alberta, Edmonton, Canada. Their recommendations were incorporated into the questionnaire which was then reviewed by an expert from the University of Manitoba, Winnipeg, Canada. Following these revisions, the modified questionnaire was sent to the IPCSSC for a final review before its implementation. The validated questionnaire is included in *Appendix C* of this report.

Phase II - Pilot Study: A pilot study which was designed to test the content and readability of the validated questionnaire was conducted from January to March 2008. Fifteen competitive athletes from selected Paralympic training centers in Australia (3), Belgium (2), Brazil (4), Sweden (2), South Africa (2) and the United States (2) received the questionnaire from their sports administrators. These questionnaires were completed by the athletes and forwarded to the IPC head office in Bonn or directly to the principal investigator at the University of Alberta. The athletes were asked to comment on the content and readability of the questionnaire. Their feedback was used to make final changes to the questionnaire before its actual implementation.

Phase III - Data Collection: Data collection was initiated in three ways: (1) An on-line version of the questionnaire, which was developed at the end of the validation phase, was posted on the IPC website so that athletes could complete this at their convenience. The on-line questionnaire was available from August to November 1st 2008. (2) The validated questionnaire was sent to members of the International Network for the Advancement of Paralympic Sports through Science (INAPSS) for distribution, and upon completion returned to the IPC headquarters. (3) Data were collected during the Paralympic Games in Beijing from 7th to 17th September 2008. This latter process included a number of steps. Firstly, managers of the National Paralympic Committees (NPCs) who attended the Paralympic Games were informed of the study at an orientation meeting one day before the games commenced. A covering letter *(Appendix D)* from the Chairperson of the IPCSSC and the study principal investigator, along with sufficient copies of the questionnaire were subsequently placed in their individual mail boxes for distribution to the spinal cord injured athletes who met the inclusion criteria of the study. A written reminder *(Appendix D)* was sent to the NPC managers during the Paralympic games to encourage their athletes to complete the questionnaire. As well, a final request *(Appendix D)* was sent to the NPC managers after the conclusion of the games, requesting them to remind the athletes to complete the on-line version of the questionnaire if they did not have the opportunity of completing it during the games at Beijing. Secondly, appropriate signage was placed at strategic locations in the Paralympic Village to inform athletes about the study and seek their participation. Thirdly, members of the investigative team also personally contacted team managers and coaches at the various practice venues to increase athlete participation. Finally, members of the investigative team telephoned the Operations Managers of the NPCs periodically asking them to remind the athletes to complete the questionnaires. The completed questionnaires were returned by the athletes to the IPCSSC office at the Paralympic Village either directly or via their NPC managers.

Phase IV, Data Analysis: A total of 99 participants completed the survey which was used for data analysis. The principal investigator consulted with the Director of the Rehabilitation Research Center, Faculty of Rehabilitation Medicine, University of Alberta on appropriate statistical techniques to analyze these data. Following this consultation, the information from these 99 questionnaires was entered into Survey Monkey (www.surveymonkey.com) which is a software program that can be used for processing questionnaire data. Statistics describing the responses to the research questions which were outlined in *Appendix A* were initially conducted using this software. The data were then exported into SPSS to perform the Fisher Exact test to compare the frequencies of the responses with respect to the following variables: (1) gender, (2) level of education, (3) duration of injury, and (4) sport participation. This statistical technique has been designed specifically for the analysis of contingency tables of categorical data where the sample sizes are small and/or when there are fewer than five subjects per cell (Fisher 1970). The test produces an exact probability but α was set at 0.05. Caution needs to be applied in interpretation of the results even though this test was used because in many instances cell sizes were small and often 0. Consequently trends in the descriptive characteristics have been reported where pertinent.

Phase V, Final Report: A preliminary draft of the final report was prepared by the Principal Investigator (YB) and a co-investigator (JM). It was then reviewed by another co-investigator (SW), and after incorporating this feedback, it was sent to the remaining members of the IPCSSC for three further reviews. Their recommendations were incorporated into the document and then submitted to WADA in fulfillment of the terms of the research grant agreement.

Section 5: Results

(a) Characteristics of Participants

(i) Personal Characteristics *(Appendix E, Table 1)*

Some pertinent characteristics of the 99 participants who completed the Boosting Questionnaire are summarized in Table 1. Four participants did not indicate their gender. Of the remaining 95 participants, 84 (88.4 %) were male and 11 (11.6 %) were female. In both genders, majority of the participants were in the 34 to 39 year age group (31. 3%), followed by the 28 to 33 yr (23.3%), 16 to 21 yr (20.1%) and 40 to 45 yr (12.1%) age groups. A considerable variation was observed in the educational level of the participants. Approximately 17% of them had some high school education while 28% of them had completed their high school diploma. Approximately 21% of the participants had enrolled in post secondary institutions but had not completed their undergraduate degrees. However, 13% of them had undergraduate degrees while 17% completed graduate degrees. Approximately 12% of the participants were either part time or full time students, while 24% of them were either part time or full time athletes. Overall, 26% of the participants indicated that they were self- funded athletes while 24% were athletes funded by the state or province. Approximately 16% of the participants indicated that they were funded by other sources. In the combined group, 17% of the participants were part time paid employees while 14% were employed on a full term basis. Nine percent of the participants were self employed on a part time basis while 11% were self employed on a full time basis. Of the 14% of the participants who were unemployed, 4% were looking for employment and the remaining 10% were not seeking employment.

(ii) Spinal Cord Injury Lesions *(Appendix E, Table 2)*

With respect to the spinal cord injury, 95 % of the participants were aware of their specific lesion level while 5% did not know their lesion level. Those who were aware indicated lesion levels ranging from C5-7 (high level quadriplegia) to T6 (high level paraplegia). Of these, 44.6% had a complete spinal cord injury while 44.4 % had an incomplete injury. The remainder (11%) did not provide this information. There was a large variation in the duration of injury amongst the participants. In the combined group, 11 participants (12.1%) had a spinal cord injury for 1 to 5 years, 18 (19.7%) were injured for 6 to10 years, 22 (24.17%) were injured for 11 to15 years, and 40

(44%) were injured for 16 or more years. When the participants were queried whether they were able to experience autonomic dysreflexia spontaneously based on their injury level *(Question 3a)*, only 54 (54.5%) of them responded to the question. Of those who responded, 43 (79.6%) answered positively while 11 (20.4%) answered negatively. However, when they were asked whether they had spontaneously experienced autonomic dysreflexia *(Question 22),* 61 of the 92 respondents (66.3%) answered positively while 25 (27.2%) answered negatively. Six of the participants (6.5%) did not know whether they spontaneously experienced autonomic dysreflexia and three participants did not respond to the question.

(b) Sport Participation

The frequency of participation in the different sports is illustrated in *Figure 1, Appendix F.* In the combined sample, a large majority of the participants (54.2%) were involved in wheelchair rugby. This was followed by wheelchair sprint events (10.4%), wheelchair basketball and middle distance events (9.4% each), marathon racing, long distance racing and throwing events (6.3% each). Participants indicated that they competed in other events not indicated on the questionnaire 20.8% of the time. With respect to the two winter sports listed in the questionnaire, two participants (2.1%) identified Nordic skiing and none of them identified alpine skiing.

(c) Awareness of Boosting (Appendix E, Table 3, N = 93 Responses)

Of the 93 participants who responded to this question, 52 (55.9%) had heard of boosting prior to reading about it in the questionnaire. Among the remaining 41 participants, 38 (40.9%) had not heard of boosting previously, 3 (3.1%) participants were unsure and 3 (3.1%) participants did not respond to the question. The frequency of males who had prior knowledge of boosting was significantly grater than that of females *{Fisher's Exact (2, N = 93), P = .016}.*

(d) Incidence of Boosting

In *Question #3b*, the participants were asked: "*Have you ever intentionally induced autonomic dysreflexia to boost your performance in training or competition?"* Of the 60 participants who responded, 10 (16.7%) responded affirmatively while 50 (83.3%) responded negatively. Among the participants who indicated that they had used boosting, approximately two thirds of them reported that they had never used boosting during the following phases: (i) regular training (64.7%), (ii) while training to peak for competition (66%), (iii) in national competitions

(64%), and (iv) in international competitions (62%). A small proportion (6% to 14%) of respondents used boosting during the two training phases or competitions identified above. Only one participant (2%) indicated that he used boosting all the time during national and international competitions to improve performance.

(i) Gender *(Appendix E, Table 4, N = 60 responses)*

As indicated earlier, 4 of the 99 participants did not indicate their gender on the questionnaire. In the subgroup of 60 participants who responded to *Question #3b*, 52 were males, 6 were females, and the gender of 2 participants was not known *(Table 4a).* Nine of these participants, all males, indicated that they had used boosting during competition and/or training. All these participants had previously experienced autonomic dysreflexia spontaneously. The statistical analysis revealed that there was a significant difference in the incidence of boosting between males and females *{Fisher's Exact (1, N = 58), P = .000, Table 4b}.*

(ii) Age *(Appendix E, Table 5, N = 59 responses)*

Examination of the differences in the frequency of boosting by age revealed that the younger subjects aged between 16 to 27 years of age and the oldest subjects aged more than 46 years of age had never voluntarily used boosting to enhance their performance in training and/or competition. However, 12.5%, 15.8% and 33.3% of the participants aged between 28 to 33, 34 to 39 and 40 to 45 years respectively used boosting to improve their performance in training and/or competition. The statistical analysis indicated that there was no significant difference in incidence of boosting among age categories *{Fisher's Exact (4, N = 59), P = 0.339}.*

(iii) Level of Education *(Appendix E, Table 6, N = 48 responses)*

Most of the subjects surveyed, regardless of the level of education, had not voluntarily used boosting to enhance their performance in training and/or competition. Of these 48 respondents, eight indicated that they had used boosting to enhance training and/or competition. Three participants (37.5%) had some postsecondary education, one (12.5%) had some university education and four (50%) had graduate degrees. The statistical analysis revealed that there was a statistically significant difference in the incidence of boosting by education level *{Fishers Exact (4, N = 48), P = 0.033}.*

(iv) Injury Level *(Appendix E, Table 7, N = 55 responses)*

Although the incidence of boosting appeared to be higher in participants with cervical injuries (C5 to C7), when compared to participants with injuries at the thoracic level (T1 to T3 and T4 to T6 collapsed), the statistical analysis revealed that there was no significant difference in the incidence of boosting by level of injury *{Fisher's Exact (2, N = 55), P = 0.370}.*

(v) Type of sport/event *(Appendix E, Table 8, N = 48 respondents)*

Among the participants who used boosting to improve performance in training and/or competition, the incidence was highest among wheelchair rugby players (5 participants, 55.5%) followed by those participating in wheelchair athletics, namely, marathon racing (2 participants, 22.2%) and long distance racing (2 participants, 22.2%). None of the participants involved in wheelchair basketball and throwing events used boosting to enhance performance in training or competition. The statistical analysis revealed that there was no significant difference in the incidence of boosting across sports *{Fisher's Exact (4, N = 48): P = 0.506}.*

(e) Knowledge of Boosting

(i) Level of Education *(Appendix E, Table 9, N = 76 responses)*

The descriptive statistics showed that participants who had graduated from high school were less likely (44%) to have previously heard of boosting compared to those who had some post secondary education (54.5%), some university education (60%), an undergraduate degree (61.5%) and a graduate university degree (64.7%). However, the statistical analysis revealed that there was no significant difference in their previous knowledge about boosting by level of education *{Fisher's Exact (8, N = 76), P = 0.717}.*

(ii) Duration of Injury *(Appendix E, Table 10, N = 88 responses)*

The percentages of participants who had previous knowledge of boosting as a performance enhancing strategy were 27.3%, 55.6%, 63.2%, and 65% in the 1-5 years, 6-10 years, 11-15 years, and >16 years post injury duration respectively. There was no significant difference in previous knowledge about boosting by duration of injury *{Fisher's Exact (6, N = 88), P = 0.12},* but there was a trend towards greater knowledge of boosting 6 years post injury.

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(iii) Sport Utility *(Appendix E, Tables 11 and 12, N = 48 and 55 respectively)*

With respect to the use of boosting in their sport, approximately 27.1% of the participants reported that boosting was commonly used in their sport while 35.4% were not sure about its use. Statistical analysis *(Table 11)* indicated that there was no significant difference on knowledge about boosting in their sport by educational level *{Fisher's Exact (16, N = 48), P = 0.584} }* although there was a trend for those with some post secondary education to believe that it was commonly used in their sport. When these responses were analyzed with respect to injury duration, 29.1% of the respondents indicated that it was commonly used in their sport while 32.7% were not sure of the frequency of its use. Once again, there was no significant difference *(Table 12)* on knowledge about boosting and injury duration of the participants *{Fishers Exact (12, N = 55), P = 0.217}* although there was tendency for those with 16+ years injury duration to believe that it was more commonly used.

(iv) Sport Participation

Only 29 (28 males and 1 female) of the 99 participants responded to *Question #9* regarding sport participation. These participants reported that boosting was *most useful (Figure 2, Appendix F)* in middle distance events (78.6%), long distance events (71.4%), marathon racing (64.3%) and wheelchair rugby (64.3%). This was followed by sprint events (57.1%), wheelchair basketball (32.1%), Nordic skiing (21.4%), alpine skiing (10.7%), throwing events (10.7%) and other events (3.6%). When queried about the sport in which boosting would be the *least useful (Figure 3, Appendix F),* majority of the participants identified throwing events (55.6%) and alpine skiing (51.9%). Only a small percentage of the respondents identified middle distance (3.7%), long distance (11.1%) and marathon racing (25.9%) as the events that were least benefited by boosting. Corresponding values for sprinting events, wheelchair basketball and wheelchair rugby were 25.9%, 25.9% and 11.1% respectively.

Majority of the participants indicated that boosting was *most useful during competition* (80.5%) when compared to the other phases such as during training (9.8%) or immediately prior to competition (7.3%). The frequencies of the variables that they felt benefited the most from boosting during competition are illustrated in *Figure 4*, *Appendix F.* The three most frequently reported benefits of boosting during competition that were cited were *increased circulation, less fatigue and increased arm endurance along with increased aggression and increased alertness.* However, a small number of participants also reported *increased anxiety and greater frustration* as possible effects of boosting during competition. The participants reported that the main source of knowledge was their personal experience (62.5%) and reports from other athletes (46.4%).

(v) Dangers of Boosting *(Appendix E, Tables 13, 14, and 15, N = 57, 47 and 54 responses respectively*)

Forty nine percent of the male and female participants agreed that boosting was somewhat dangerous to health. However, 21.1% and 24.6% of the respondents also felt that boosting was dangerous or very dangerous to health respectively. Only a small proportion (4%) of the respondents said that boosting was not at all dangerous. Generally speaking, both males and females had a similar opinion regarding the dangers of boosting. Statistically, there were no significant differences in the frequency of responses regarding the dangers of boosting by gender when the category not dangerous at all was compared to any level of danger, although males were more spread over the various categories {*Fishers Exact (3, N = 57) P = .615, Table 13*}. Similarly, there were no significant differences in the frequency of responses with respect to dangers of boosting when they were examined by education level {*Fishers Exact (12, N = 47) P = .106, Table 14}* or the injury duration {*Fishers Exact (9, N = 54) P = .421, Table 15}* of the participants.

(vi) Symptoms of Boosting

With respect to the symptoms of boosting, most of the respondents identified headache (70.9%), excessive sweating (80.6%), and high blood pressure (83.3%) as the most frequent ones. Shivering (36.8%) and blurred vision (26%) were less frequently reported by the participants. The frequencies of these symptoms are illustrated in *Figure 5, Appendix F.* The main source of knowledge regarding the symptoms of boosting was their personal experience (61.7%) and reports from other athletes (50%). The participants gained some information by reading about boosting (22.9%) and received only minimal information (2.1 %) from their coaches. When queried about the consequences of boosting, most of the subjects identified high blood pressure (86%), stroke/cerebral hemorrhage (59.6%), and death (44%) as possible outcomes. Only a small proportion (16.1%) identified seizures as being a possible consequence of boosting.

(f) Attitude towards Boosting

(i) Gender *(Appendix E, Tables 16, N = 61 responses)*

Majority of the males and females indicated that using boosting to improve training capacity, maximize performance during competition, because their competitors were using it, and boosting itself was unacceptable. There was no significant gender difference in the frequency of the responses to this question {*Fishers Exact (4, N = 61) P* = .875, *Table 16*} although there was a trend according to the descriptive statistics for males to see it as being more acceptable.

(ii) Level of Education (Appendix E, Table 17, N = 51 responses)

When these responses were analyzed with respect to level of education, there were no significant differences in the frequency of these responses in either gender {*Fishers Exact (16, N = 51) P* = .773, *Table 17}.*

(iii) Injury Duration (Appendix E, Table 18, N = 58 responses)

Evaluation of these responses with respect to injury duration revealed that there was no significant influence in either gender {*Fishers Exact (12, N = 58) P* = .793, *Table 18}.* When the participants were queried whether *"boosting should not be banned because it can happen unintentionally"* their opinion was split. Approximately 25% of the participants found this unacceptable while 37% were in agreement with the statement. Similarly, the participants expressed opposing views in responding to the statement *"boosting should not be banned because any athlete with T6 or higher spinal cord injury can decide to induce autonomic dysreflexia."* However, majority of them were not in agreement with the following statements: (1) *"only practices that are not available to all athletes in the same class should be banned", and (2) "showcasing the talents of athletes, and by extension the capabilities of people with disabilities, is far more important than whether or not someone is boosting."*

(g) Other Methods of Performance Enhancement

Approximately 50% of the participants indicated that they currently used one or more methods to improve performance in training and/or competition besides boosting. The frequency of use of these methods is illustrated in *Figure 6, Appendix F*. A total of 10 different methods were reported with the *most common ones being protein supplementation (21), carbohydrate loading (9) and use of energy drinks (8).* One participant reported the use of herbal supplements and another adapted climatic training to enhance performance, but neither of them provided any details. With the exception of one participant, all of them indicated that the methods utilized had no associated health risks and were legal. The exception reported using an illegal *"Medical Doping"* technique for enhancing performance and was unsure about its safety.

Almost 100% of the participants reported that using banned drugs to improve training capacity and maximize performance was unacceptable. These participants also indicated that using banned drugs because their competitors were using them was unacceptable. They clearly were against the use of banned drugs by athletes for any purpose. In responding to the general question *whether doping was a concern in Paralympic sports*, 50% of the participants indicated that it was sometimes a concern, while 24% and 26% reported that it was *not a concern* or a *major concern* respectively.

Section 6: Discussion

(a) Characteristics of Participants

A total of 99 participants completed this questionnaire with majority (89%) of them being males. It is not surprising, therefore, that the males demonstrated considerable variability with respect to their age, level of education, employment status, and source of funding compared to the females *(Appendix E, Table 1).* The male participants also had greater variability with respect to the level of injury (C5 to T6) and duration of injury (1 to 18 years) compared to the females (C5 to T4 and 3 to 16 years respectively) *(Table 2).* It is noteworthy that only 25% of the combined sample was within the 16 to 27 year age group while 20% was above 40 years. Approximately 55% of the combined sample was within the 28 to 40 year age range. This high age range is most likely due to the fact that many of the participants had incurred their spinal cord injuries later on in life and became involved in Paralympic sport at an older age when compared to able bodied athletes.

(b) Sport Participation

The participants in this study represented three main summer sports, namely, athletics (track and field), wheelchair basketball and wheelchair rugby. Majority of them competed in wheelchair rugby (54.2%), followed by wheelchair track events (marathon, long distance, middle distance and sprints; 32%), wheelchair basketball (9.4%) and field events (6.3%). It should be noted that although wheelchair rugby is a co-ed team sport (www.pararlympic.org), there was only one female wheelchair rugby participant in the Paralympic games. One of the two athletes who participated in

Nordic skiing in the previous winter Paralympics also participated in a middle distance wheelchair racing event at the Beijing Paralympic games.

(c) Awareness and Incidence of Boosting

The current results indicated that 52 of the 95 participants whose gender was known (55.9%) had previously heard of boosting to enhance performance, while 40.9% of them were unaware of this practice and the remainder was unsure. This awareness was significantly greater in males compared to female participants *(Table 4b) and* did not differ by the age *(Table 5)* and the injury duration *(Table 7)* of the participants. Although male participants who had university undergraduate or postgraduate degrees were more aware of this practice *(Table 6),* this finding should be interpreted with caution due to the relatively small number of participants. A similar finding was observed with respect to the duration of injury; participants who had their injuries for a longer duration tended to be more aware of boosting compared to those with shorter injury durations. *The fact that a significant proportion of the athletes with spinal cord injuries above the T6 level had not heard of the practice of boosting further stresses the need for developing educational programs for this population.*

Only 60 of the 99 participants responded to the question: "*Have you every intentionally induced autonomic dysreflexia to boost your performance in training or competition"* The reason for the low response rate to this question is not known, but could be due to participants' apprehension for disclosing information that could possibly incriminate themselves in a technique that is deemed illegal by the International Paralympic Committee (www.paralympic.org). This was despite the fact that the questionnaire was designed to ensure anonymity; *the participants were not required to provide their name or country of origin on the questionnaire.* Among the participants who responded to this question *(Table 4b),* 15.5% % (9 out of 58) indicated that they had previously used boosting to enhance performance in training or competition while the remaining 84.5 % had not used this method. It is particularly noteworthy that all the participants who used this method were males, with a majority of them competing in wheelchair rugby (5 out of 9 or 55.5 % of the participants who responded to this question, *Table 8a*). The other four positive responses were received from athletes who competed in long and middle distance wheelchair racing events. The fact that majority of the "boosters" were wheelchair rugby players was most likely due to the fact that they comprised the largest proportion (54.2%) of the participants in this study. With respect to the frequency of boosting, approximately two thirds of the athletes indicated that they had not used it during training or during national and international competitions. A small percentage of the participants (6 to 14%) reported using this technique to enhance performance during training and competition, while only one participant indicated that he used it all the time in national and international competitions to enhance performance. *The fact that several participants used boosting during training is of serious concern because most athletes, particularly those competing in individual sports, tend to train on their own with minimal amount of supervision. The possibility of an adverse event due to an exaggerated blood pressure response resulting from boosting during training has important implications for developing educational programs pertaining to this practice.*

The results of this preliminary investigation indicated that the incidence of boosting did not differ by the age *(Table 5)* of the participants. This could be explained by the fact that a spinal cord injury can occur at any stage in life, and therefore, may not have any bearing on the athlete's decision to boost or not to boost. The current findings also revealed that there was no significant difference in the incidence of boosting by the level of spinal injury of the participants *(Table 7).* To further explore this question, we examined the difference in the incidence of boosting between participants who spontaneously experienced autonomic dysreflexia *(Question 22)* and those who decided to boost themselves to enhance performance during training and/or competition *(Question 3b)*. Once again, the results indicated that there was no significant difference *{Fisher Exact (2, N = 48) P = 0.312}* by these two variables, suggesting that prior experience of autonomic dysreflexia did not influence the participants' decision to boost for performance enhancement. However, it is interesting to note that the incidence of boosting was significantly associated with the level of education of the participants *(Table 6).* Those who had graduate university degrees (N = 4) boosted more frequently when compared to participants who had some high school (N = 0) and some post secondary (N = 3) education. This finding should be interpreted with caution because of the small number of subjects that boosted in each of the educational categories.

(d) Knowledge of Boosting

(i) Sport Performance

The participants' knowledge pertaining to the effects of boosting on athletic performance was quite varied. Approximately 40% of the athletes felt that boosting definitely had a beneficial effect on some sports while an equal proportion was unsure of such benefits *(Table 10).* Majority of the participants felt that boosting would be most beneficial in wheelchair racing events such as the marathon, long distance and middle distance races *(Figure 3).* From a physiological standpoint, these races are primarily dependent upon aerobic metabolism and would therefore benefit the most when the athletes are in a boosted state (Bradbury T, 2001; Schmid et al., 2001). However, what is surprising is that 64.3% of the respondents also indicated that boosting would benefit wheelchair rugby performance which is a high intensity, intermittent sport that is not dependent primarily upon aerobic metabolism. It is possible that factors such as increased aggression and alertness (Avois et al., 2006) that were reported by some athletes, which could be attributed to the enhanced catecholamine response in the boosted state during exercise (Schmid et al., 2001; Wheeler et al., 1994), could explain this response.

(ii) Health Effects

In this study, 96% of the subjects were aware that boosting could be dangerous to health. While approximately 50% of the participants felt that boosting was somewhat dangerous, 46% of the participants reported that it was dangerous or very dangerous to health. Further analysis revealed that 7 out of 9 participants who had used boosting indicated that it was somewhat dangerous to health, while one participant indicated that it was very dangerous and the remaining participant felt that it was not at all dangerous to health. The participants identified excessive sweating, high blood pressure and headache as the most frequent symptoms of boosting, while shivering and blurred vision were reported less frequently. It should be noted that two of these symptoms, namely excessive sweating and shivering, are easily visible and are frequently used to identify whether spinal cord injured athletes are in the boosted state during competitions (Bhambhani, 2002). When queried about the consequences of boosting, approximately 60% of the participants identified stroke/cerebral hemorrhage and 44% identified death as possible outcomes. The awareness of the signs/symptoms and consequences of boosting was not associated with the education level or the injury duration of the participants. They indicated that they gained most of this knowledge through their personal experiences or from discussions with other athletes. *Only 22.9% of them indicated that they learned about boosting from reading, while 2.1 % leaned about it from their coaches.* These findings are not surprising because of the following reasons. Firstly, although much has been written about the clinical effects of autonomic dysreflexia which occurs spontaneously (Bloch RF, 1986; Karlsson, 1999; Lee, Karmakar, Herz, & Sturgill, 1995), there is minimal published scientific information pertaining to its voluntary induction (ie. boosting) that is available to athletes. The available boosting studies have focused strictly on the physiological responses of the athletes during exercise (Burnham R, Wheeler G, Bhambhani Y, Belanger M, Eriksson P, Steadward R., 1994; Schmid et al., 2001; Wheeler et al., 1994). Secondly, the findings of two surveys (Bradbury T, 2001; Chow & Mindock, 1999) indicated that majority of the elite athletes with disabilities do not have professionally trained coaches, and therefore, rely on themselves for acquiring relevant information. One former Paralympic athlete (Raymond S., 1994) clearly stated that *"education should be given to athletes about all the aspects of boosting. To permit participation of 'unboosted' athletes, new standards should be fixed to ensure rights for those who do not use boosting."*

(e) Attitude towards Boosting

The participants in this study, both males and females, were strongly opposed to the use of boosting to improve training capacity, enhance performance during competition, and because their competitors were using it. This opinion was independent of their education level, employment status, and duration of injury. *It should be noted that despite their knowledge pertaining to the dangers (Table 13) and adverse health effects of boosting (Figure 5), 16.7% of the participants indicated that they had used it to enhance performance during training and/or competition. This finding should be of concern to the athletes, coaches and trainers, as well as the governing bodies of the Paralympic sport organizations.*

Random monitoring of athletes suspected of boosting was first implemented at the Sydney Paralympic games in 2000. During the 2008 Beijing Paralympic games, a total of 20 athletes, 16 wheelchair racers and four hand cyclists were tested for boosting. This is a relatively small number compared to the total number of athletes with high level spinal cord injuries that participated in the games and the overall number of events that they competed in. None of these athletes demonstrated a positive response on the basis of their blood pressure measurements. It should be noted that the results of this study indicated that only one participant used boosting all the time during national and international competitions. *It is recommended that the frequency of boosting tests at the Paralympic games and other IPC sanctioned events be increased considerably so that the trends in this method of coping can be systematically evaluated.*

(f) Other Methods of Performance Enhancement

Approximately 40% of the participants indicated that they used other methods for performance enhancement which they considered to be legal and safe. The most commonly used methods *(Figure 6)* were protein supplementation (21), carbohydrate loading (9) and use of energy drinks (8). Generally speaking, these methods are based on sound physiological principles and are recommended for use by able bodied athletes competing at the elite level (Gleeson & Bishop, 2000; Juhn, 2003). It should be noted, however, that much of the scientific research on the nutritional aspects of sport performance has been conducted on able bodied athletes (Grandjean, 1997) and may not necessarily apply to athletes with disabilities. As indicated earlier, one participant reported the use of an illegal *"medical doping"* method and was unsure about its safety. *Obviously this is a cause for concern and further stresses the need for additional monitoring of athletes and the development of educational programs for athletes and coaches.*

(g) Participants' Comments Pertaining to Boosting and Doping

In *Question #26*, the participants were given the opportunity to provide feedback to the investigators regarding the use of boosting, doping and any other legal or banned performance enhancing strategy. The grammatically edited comments of the 22 participants who responded to this question are available in *Appendix G.* Eighteen of these comments were pertinent to boosting and were quite varied. Most participants felt that boosting should be banned and that there should be more frequent testing to minimize its use. However, another participant felt that because this can happen spontaneously, athletes could be penalized unfairly for a disability related reflex that they have no control over. Yet another point of view expressed was that if it was possible for all athletes to induce boosting, it would be good. At the other extreme, one participant stated that *"if boosting isn't controlled someone will die."* It should be noted that one participant stated that there was very little control (monitoring?) over boosting in South Africa and recommended that educational campaigns start at the junior level. With respect to their opinion about other forms of doping, there was unanimous agreement that these should be banned and that there should be more rigorous monitoring of such practices.

(h) Limitations of the Study

(i) Sample size

Due to the relatively small sample size in this study, the number of responses in the categorical variables for many of the questions was very low. Although the statistical test, namely the Fisher Exact test, is specifically designed for small sample sizes (below five per cell), the current findings could be limited by low statistical power and distortion between categories due to the small number of respondents in many cells. Therefore visual analysis of the descriptive statistics should be given some weight despite any lack of statistical significance.

(ii) Gender Comparisons

The ratio of male (N = 84) to female (N = 11) participants in this study was approximately 8:1. The gender distribution of the 241 potential participants at the Beijing Paralympic Games is not available, and therefore, it is not clear whether the present distribution is representative of the participation in the games. However, it is likely that the males who met the inclusion criteria outnumbered the females, because all but one of the participants in wheelchair rugby, the sport that comprised 96 of the 241 athletes (40%), were males. *Because of the small number of female participants, there were no responses for many of the categorical variables in this study. Therefore, the generalizability of these findings to the female Paralympic population should be viewed with caution.*

(iii) Use of English language questionnaire

The current questionnaire was administered only in English, and therefore, was completed by individuals who were familiar with this language. Therefore, the findings from this study could be generalized mainly to athletes who could communicate in English. However, in some instances, non-English speaking athletes (eg. Brazil and Italy) were assisted by their coaches and team managers in completing the questionnaire during the games and are included in the total sample. *A concerted effort should be made to translate this questionnaire into other languages so that a more representative sample could be obtained and the results be generalized to a larger segment of the Paralympic athletic population.*

(iv) Regional Representation

In the interest of ensuring anonymity of the participants, the Health Research Ethics Board at the University of Alberta stipulated that they *not be required* to identify their country of residence on the questionnaire. Therefore, it was not possible to conduct an analysis of the results with respect to the country of origin in this study. *It is possible that regional differences pertaining to boosting may exist, and further research should be conducted to examine this question.*

(v) Use of Self-report Questionnaire

The use of a self-report questionnaire to obtain information on a sensitive issue such as doping runs the risk of under-reporting by the athletes, and therefore, could be misleading (Adams A, Soumerai S, Lomas J, Ross-Degnan, D., 1999). From a research perspective, it is crucial that the perspectives of the athletes' be accurately documented, so that appropriate intervention strategies could be implemented by the sport governing bodies.

Section 7: Recommendations

To the best of our knowledge, this is the first study that has systematically examined the incidence, knowledge and beliefs, and attitudes towards boosting in Paralympic athletes with high level spinal cord injuries. The lack of previous research pertaining to this topic makes it difficult to place the current results in perspective. However, *based on these preliminary findings,* these researchers make the following recommendations:

1. Develop written educational materials pertaining to the effects of boosting so that male and female athletes can increase their awareness and knowledge about this method of doping which can be dangerous to their health.
2. Educational materials be developed in an interactive manner in different languages and posted on the IPC website to enhance knowledge and learning by the athletes, coaches and trainers.
3. Coaches and trainers should be educated about this practice and convey this information to their athletes so that the overall incidence of boosting can be reduced.
4. Boosting educational programs be targeted in regions where the awareness is low.
5. Boosting programs be initiated at the junior level so that these individuals are fully aware of the dangers of boosting when they become competitive athletes.
6. The IPC conduct boosting workshops during the Paralympic games and other sanctioned competitions so as to further educate the athletes, coaches and trainers regarding this practice.
7. Educational programs be targeted to specific sports (eg. wheelchair rugby, wheelchair distance racing) in which the incidence of boosting is likely to be high.
8. The IPC increase the frequency of boosting tests at the Paralympic games and all its sanctioned competitions so that the trends in this practice can be systematically evaluated.

9. Further research should be conducted on a larger sample size of competitive spinal cord injured athletes of both genders with lesion levels above T6 so that the findings can be generalized to a larger segment of this population.

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Section 10: Appendices

Appendix A

Research Questions: Incidence, Knowledge and Attitudes towards Boosting

The following questions were developed by the researchers for the Boosting Survey. These questions were divided into *three main themes*, based on the overall objectives outlined in the research proposal. The survey question number in these tables refers to the question number in the questionnaire *(Appendix B)* that was completed by the athletes.

1. Overall theme: Incidence of boosting by characteristics of athletes

Research Questions	Survey Question #
1. What is the overall *incidence of boosting* in athletes with high level SCI?	*3b*
2. What is the *frequency of boosting* in athletes with high level SCI?	4
3. Is there a gender difference in the *incidence of boosting?*	*3b,* 21
4. Is there a difference in the *incidence of boosting* and the age of the athletes?	*3b,* 21
5. What is the difference in the *incidence of boosting* across different levels of education?	*3b,* 19
6. Is there a difference between the *incidence of boosting* and incidence of autonomic dysreflexia?	*3b,* 22
7. Is there a difference in the *incidence of boosting* and the type of sport/event?	*3b,* 24
8. Is there a difference in the *incidence of boosting* across the injury levels of the athletes?	*3b,* 25b,c

2. *Overall theme: Knowledge of boosting across: (1) levels of education, (2) duration of injury, and (3) sport participation.*

Research Questions	**Survey Question #**
1. Is there a difference in the athletes' general awareness/knowledge of boosting across different *levels of education*?	1, 6, 11, *19*
2. Is there a difference between athletes' awareness/knowledge pertaining to boosting to enhance performance across different *levels of education*?	7, 8, 9a, 9b, 10a, *19*
3. Is there a difference in the athletes' awareness/knowledge of the health effects of boosting across different *levels of education*?	12a, 12b, 13, *19*
4. Is there a difference in the athletes' general awareness/knowledge pertaining to boosting and their *duration of injury*?	1, 6, 11, *25a*
5. Is there a difference in the athletes' awareness/knowledge pertaining to boosting to enhance performance and their *duration of injury*?	7, 8, 9a, 9b, 10a, *25a*
6. Is there a difference in the athletes' awareness/knowledge of the health effects of boosting and their *duration of injury*?	12a, 12b, 13, *25a*

3. *Overall theme: Attitude towards boosting/doping across: (1) different levels of education, (2) employment/funding status, and (3and (2) duration of injury*.

Research Questions	**Survey Question #**
1. Is there a difference in the athletes' attitude towards boosting/doping in sport across different *levels of education*?	14, 15, 16, 17, 18, *19*
2. Is there a difference in the athletes' attitude towards boosting/doping and their *employment/funding status*?	14, 15, 16, 17, 18, *20*
3. Is there a difference in the athletes' attitude towards boosting/doping in sport across different *injury durations*?	14, 15, 16, 17, 18, *25a*

Appendix B:

Ethics Approval from Health Research Ethics Board

University of Alberta

Health Research Ethics Board

213 Heritage Medical Research Centre
University of Alberta, Edmonton, Alberta T6G 2S2
p.780.492.9724 (Biomedical Panel)
p.780.492.0302 (Health Panel)
p.780.492.0459
p.780.492.0839
f.780.492.7808

HEALTH RESEARCH ETHICS APPROVAL

Date: April 2006

Name of Applicant: Dr. Yagesh Bhambhani

Organization: University of Alberta

Department: Occupational Therapy

Project Title: **Boosting in elite athletes with high spinal cord injury: Awareness, knowledge and attitudes of athletes, coaches and trainers**

The Health Research Ethics Board (HREB) has reviewed the protocol for this project and found it to be acceptable within the limitations of human experimentation. The HREB has also reviewed and approved the subject information letter and consent form, if applicable.

The approval for the study as presented is valid for one year. It may be extended following completion of the yearly report form, which will be sent to you in your renewal month. Any proposed changes to the study must be submitted to the Health Research Ethics Board for approval. Written notification must be sent to the HREB when the project is complete or terminated.

Glenn G. Griener

Dr. Glenn Griener
Chair of the Health Research Ethics Board
(B: Health Research)

File number: B-240405

UNIVERSITY OF ALBERTA

Capital Health

CARITAS HEALTH GROUP

Appendix C: Validated Boosting Questionnaire

Appendix D: Correspondence with Managers of National Paralympic Committees

1. Introductory letter
2. Reminder sent during the Beijing Paralympic Games
3. Final Request sent after the Beijing Paralympic Games

Bonn, [enter date]March 2008
APBL/IPC/000

Research Investigation - 'Boosting' in Elite Athletes with Spinal Cord Injury

Dear NPC Athlete,

The IPC International Paralympic Committee Sport Science Committee has recently received funding from the World Anti Doping Agency to conduct a study into Boosting (the deliberate causing of Autonomic Dysreflexia) in elite athletes with spinal cord injury, specifically related to awareness, knowledge and attitudes of athletes, coaches and trainers..
The survey will be conducted under the supervision of the IPC Sports Science Committee.

This study will be completed in three two phases over a two year period.

In Phase I: distribution of a, a questionnaire related to the awareness, knowledge and attitudes of athletes, coaches and trainers towards boosting will be developed.

In Phase II: a hard copy and on-line questionnaire will be distributed so that it can be completed by athletes with incomplete or complete spinal cord injury at or above the T6 level.

In Phase III: the results of the survey will be analyzed and the information will be presented to the IPC and WADA.

The person that handed over the questionnaire to you identified you as a person with a complete or incomplete spinal cord injury at or above the T6 level. The IPC is seeking your help in completing Phase II I of this study by kindly requesting that your NPC distributes the attached Boosting Questionnaire and Consent Form to competitive athletes who have complete or incomplete spinal cord injuries at or above the T6 level. Alternatively please include a link on your website to the following address, where athletes may submit their information, and advise athletes accordingly:

www.paralympic.org/boosting survey

The IPC would also be grateful if you could provide any necessary translation services to those athletes who do not understand English. Please inform the athletes that the questionnaire must be returned to the IPC no later than **30th November 2008.**

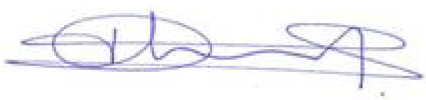
As stated in the questionnaire, the identity of those completing the questionnaire is not required and all responses will be held in the strictest of confidentiality. The questionnaire and administration procedure have been approved by the Health Research Ethics Board at the University of Alberta, Edmonton, Canada, a copy of which has been included for your information can be retrieved upon request from the IPC Headquarters.

May we invite you to return the completed questionnaire to the person that gave it to you at your earliest convenience?

Should you have any questions or require additional information on this matter, do not hesitate to contact Peter Van de Vliet, IPC Medical & Scientific Director Department at the IPC Headquarters at peter.vandevliet@paralympic.org or betsy.liebsch@paralympic.org.

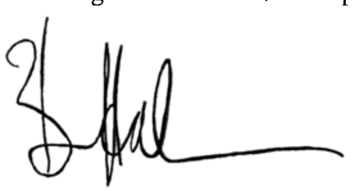
The IPC thanks you in advance for your cooperation.

Yours sincerely,



Peter Van de Vliet
Medical & Scientific Director
International Paralympic Committee

On behalf of:
Prof. Yves Vanlandewijck, chairperson IPC Sports Science Committee
Prof. Yagesh Bhambhani, Principal Investigator WADA Boosting Survey



International Paralympic Committee

9th September, 2008

REMINDER

Dear National Paralympic Committee Manager:

Re: IPCSSC Boosting Survey for Spinal Cord Injured Athletes

Dear Sir/Madam:

As you are aware, the International Paralympic Committee Sport Science Committee (IPCSSC) has received approval to conduct a survey regarding the practice of *"boosting"* in spinal cord injured athletes. Kindly remind any athletes who fulfill the following criteria to participate in this important study.

- Injury at or above the sixth thoracic level (T6 lesion)
- Complete or Incomplete injury

The survey is completely *confidential* and will take approximately *30 minutes* to complete. Kindly give the written version of the questionnaire to the athletes who meet the above eligibility criteria. I am including several copies of the questionnaire for your perusal. Please feel free to duplicate the questionnaire should you require additional copies for your athletes. **The completed questionnaires can be returned until 17th September 2008 at the following location in the Player's Village:**

IPC Medical and Scientific Department
IPC Polyclinic

If you need more information, please contact Dr. Yagesh Bhambhani at Tel: 150 1092 8007.
Thanking you,

Sincerely,

Yves Vanlandewijck, Chair
IPCSSC

International Paralympic Committee

25th September, 2008

Dear National Paralympic Committee Manager:

RE: FINAL REQUEST - IPCSSC Boosting Survey for Spinal Cord Injured Athletes

The International Paralympic Committee Sport Science Committee (IPCSSC) would like to thank you for your assistance in implementing the **"Boosting Survey"** that was funded by the Word Anti Doping Agency (WADA) during the Beijing 2008 Paralympic Games. Our sincere thanks are also extended to all the athletes who completed the survey during their competitions at the games. While we have received numerous surveys from athletes all over the world, we would like to increase the data base so that the results will be more meaningful to the IPC and WADA. We are therefore requesting you to send this **Final Request** for completing the on-line Questionnaire to any spinal cord injured athletes who fulfill the following criteria:

- Injury at or above the sixth thoracic level (T6 lesion)
- Complete or Incomplete injury

If the athlete is unable to complete the on-line version of the questionnaire, then a hard copy can be printed and returned to the IPC Headquarters in Bonn at the following address:

Dr. Peter van de Vliet
Medical and Scientific Director
International Paralympic Committee
Adenauerallee 212-214, 53113 Bonn, Germany

The final deadline for sending the Questionnaire is **1st November 2008**. Once again, thank you for assisting the IPCSSC in this important research project.

Sincerely,

Dr. Yves Vanlandewijck, Chair
IPCSSC

Attachment: WADA Boosting Questionnaire

Appendix E

Summary Tables

Note: The Fisher Exact test was used in Tables 3 to 18 because the number of responses in the categorical variables was less than 5 in one cell.

Table 1: Characteristics of Participants

Group*	Variable	Number of Participants in Each Category					
Males	Age Group	16 - 21	22 - 27	28 - 33	34 - 39	40 - 45	46+
N = 85		4	17	21	26	12	5
	Status	S-PT	S-FT	A-PT	A-FT	A-SF	A-SG/OF
N = 72		6	3	9	9	21	17/6
	Employment	PE-PT	PE-FT	SE-PT	SE-FT	UE-LW	UE-NLW
N = 60		15	13	8	10	4	10
	Education	SHS	HSG	SPS	SU**	UD	GD
N = 83		15	25	10	10	10	13
Females	Age Group	16 - 21	22 - 27	28 - 33	34 - 39	40 - 45	46+
N = 11		1	2	1	4	0	3
	Status	S-PT	S-FT	A-PT	A-FT	A-SF	A-SG/OF
15		0	2	0	2	3	2/6
	Employment	PE-PT	PE-FT	SE-PT	SE-FT	UE-LW	UE-NLW
5		2	1	1	1	0	0
	Education	SHS	HSG	SPS	SU**	UD	GD
10		1	2	1	0	3	3
Combined	Age Group	16 - 21	22 - 27	28 - 33	34 - 39	40 - 45	46+
N = 99		5	20	23	31	12	8
	Status	S-PT	S-FT	A-PT	A-FT	A-SF	A-SG/OF
N = 90		6	5	9	13	24	20/13
N = 65	Employment	PE-PT	PE-FT	SE-PT	SE-FT	UE-LW	UE-NLW
		17	14	9	11	4	10
N = 96	Education	SHS	HSG	SPS	SU**	UD	GD
		17	28	11	10	13	17

*three four participants did not indicate their gender on the questionnaire (Question #25)

N = number of participants who responded to that question

S-PT = Student Part Time; S-FT = Student Full Time; A-PT = Athlete Part Time; A-FT = Athlete Full time; A-SF = Athlete Self Funded; A-SGOF = Athlete State/Government/Other Funding

PE-PT = paid employee, part time; PE-FT = paid employee, full time; A-PT = athlete, part time; A-FT = athlete, full time; A-SF = athlete, self funded; A-SG/OF = athlete, state funded/other source

SHS = some high school; HSG = high school graduation; SPS = some post secondary education; SU = some university (no degree); ED = undergraduate degree; GD = graduate degree

Table 2: Injury Details of Participants*

Group*	**Variable**				
Males	Level	C56-C7	T1-T3	T4-T6	
N = 79		65	3	11	
	Duration, yrs	1-5	6-10	11-15	16+
		11	18	17	33
Females	Level	C65-C7	T1-T3	T4-T6	
N = 8		5	0	3	
	Duration, yrs	1-5	6-10	11-15	16+
		0	0	2	6
Combined	Level	C56-C7	T1-T3	T4-T6	
N = 87		70	3	14	
	Duration, yrs	1-5	6-10	11-15	16+

*Note: 12 participants did not answer this question

Table 3: Prior knowledge of boosting in males and females with high level spinal injury (N = 93 responses)

1. Before reading about it on this questionnaire, have you every heard *of boosting* as a performance enhancing strategy?

	Please check the appropriate box for each of the following items.		
	female	male	Response Totals
yes (go to #2)	18.2% (2)	61.0% (50)	55.9% (52)
no (go to #20)	81.8% (9)	35.4% (29)	40.9% (38)
not sure (go to #20)	0.0% (0)	3.7% (3)	3.2% (3)
answered question	11	82	93
		skipped question	2

Fisher's Exact (2, N = 93): P = 0.016

Table 4a: Overall incidence of boosting in high level spinal injured athletes (N = 60 responses)

3b. If you answered yes to question 3a, have you ever intentionally induced autonomic dysreflexia to boost your performance in training or competition?	Response Percent	Response Count
yes	16.7%	10
no	83.3%	50
answered question		60
skipped question		39

Table 4b: Gender differences in incidence of boosting in high level spinal cord athletes (N = 58 responses)

3b. If you answered yes to question 3a, have you ever intentionally induced autonomic dysreflexia to boost you r performance in training or competition?	Please check the appropriate box for each of the following items.		
	female	male	Response Totals
yes	0.0% (0)	17.3% (9)	15.5% (9)
no	**100.0% (6)**	**82.7% (43)**	**84.5% (49)**
answered question	6	52	58
skipped question			37

Note: One participant who boosted did not indicate their gender. Therefore, the gender comparison is based on 9 participants who indicated that they had used boosting to enhance performance.

Fisher's Exact (1, N = 58): P = 0.000

Table 5: Incidence of boosting in high level spinal injured athletes across age groups

(N = 59 responses)

3b. If you answered yes to question 3a, have you ever intentionally induced autonomic dysreflexia to boost your performance in training or competition?

	Please check the appropriate box for each of the following items.					
	22-27	**28-33**	**34-39**	**40-45**	**46+**	**Response Totals**
yes	0.0% (0)	12.5% (2)	15.8% (3)	33.3% (4)	0.0% (0)	15.3% (9)
no	**100.0% (8)**	**87.5% (14)**	**84.2% (16)**	**66.7% (8)**	**100.0% (5)**	**84.7% (50)**
answered question	8	16	19	12	5	59
					skipped question	**34**

Fisher's Exact (4, N = 59): P = 0.339

Note: All the participants who responded “yes” were males.

Table 6: Incidence of boosting across different levels of education in high level spinal injured athletes (N = 48 responses)

3b. If you answered yes to question 3a, have you ever intentionally induced autonomic dysreflexia to boost your performance in training or competition?

	What is the highest level of education you have completed?					
	high school graduation	some post-secondary (not university)	some university (not degree)	undergraduate university degree	graduate university degree	Response Totals
yes	0.0% (0)	37.5% (3)	20.0% (1)	0.0% (0)	30.8% (4)	16.7% (8)
no	**100.0% (15)**	**62.5% (5)**	**80.0% (4)**	**100.0% (7)**	**69.2% (9)**	**83.3% (40)**
answered question	15	8	5	7	13	**48**
					skipped question	**31**

Fisher's Exact (4, N = 48): P = 0.033

Note: All the participants who responded "yes" were males.

.

Table 7: Incidence of boosting across injury levels in high level spinal injured athletes (N = 55 responses)

3b. If you answered yes to question 3a, have you ever intentionally induced autonomic dysreflexia to boost your performance in training or competition?

	what is the level of your injury?			
	High level (C5, C6, C7)	Middle level (T1-T3)	Low level (T4-T6)	Response Totals
yes	19.5% (8)	50.0% (1)	8.3% (1)	18.2% (10)
no	80.5% (33)	50.0% (1)	91.7% (11)	81.8% (45)
answered question	41	2	12	55
			skipped question	36

Fisher's Exact (2, N = 55): P = 0.370

Note: Nine of the 10 participants were males. The gender of the tenth participant is not known. See Results Section (b) on page 17.

Table 8a: Incidence of boosting in high level spinal injured athletes participating in different sports (N = 48 responses)

3b. If you answered yes to question 3a, have you ever intentionally induced autonomic dysreflexia to boost your performance in training or competition?

	Which sports/events do you participate in? Please check all that apply.					
	wheelchair athletics	long distance events	throwing events	wheelchair basketball	quad rugby	Response Totals
yes	18.2% (2)	40.0% (2)	0.0% (0)	0.0% (0)	17.2% (5)	16.7% (8)
no	**81.8% (9)**	**60.0% (3)**	**100.0% (6)**	**100.0% (3)**	**82.8% (24)**	**83.3% (40)**
answered question	11	5	6	3	29	**48**
					skipped question	**28**

Fisher's Exact (4, N = 48): P = 0.506

Note: Only 48 of the 60 participants who responded to Question #5 answered this question.

Table 8b: Frequency of boosting in high level spinal injured athletes who reported use of boosting (N = 53 responses)

4. With 1 being never and 5 being all the time, please circle the number that best reflects how often you use boosting in:

	1	2	3	4	5	n/a	Response Count
your regular training program	**64.7% (33)**	7.8% (4)	9.8% (5)	0.0% (0)	0.0% (0)	17.6% (9)	51
your peaking for competition training program	**66.0% (33)**	6.0% (3)	14.0% (7)	0.0% (0)	0.0% (0)	14.0% (7)	50
national competitions	**64.0% (32)**	10.0% (5)	10.0% (5)	0.0% (0)	2.0% (1)	14.0% (7)	50
international competitions	**62.0% (31)**	8.0% (4)	14.0% (7)	0.0% (0)	2.0% (1)	14.0% (7)	50
						answered question	**53**
						skipped question	**46**

Note: All the participants who responded were males.

Table 9: Knowledge of boosting across different levels of education in high level spinal injured athletes (N = 76 responses)

1. Before reading about it on this questionnaire, have you every heard of boosting as a performance enhancing strategy?

	What is the highest level of education you have completed?					
	high school graduation	some post-secondary (not university)	some university (not degree)	undergraduate university degree	graduate university degree	Response Totals
yes (go to #2)	44.0% (11)	**54.5% (6)**	**60.0% (6)**	**61.5% (8)**	**64.7% (11)**	**55.3% (42)**
no (go to #20)	**48.0% (12)**	45.5% (5)	40.0% (4)	38.5% (5)	35.3% (6)	42.1% (32)
not sure (go to #20)	8.0% (2)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	2.6% (2)
answered question	25	11	10	13	17	76
					skipped question	3

Fisher's Exact (8, N = 76): P = 0.717

Table 10: Knowledge of boosting across different injury durations in high level spinal injured athletes (N = 88 responses)

1. Before reading about it on this questionnaire, have you every heard of boosting as a performance enhancing strategy?

	For how many years have you had the spinal injury?				
	1-5 years	**6-10 years**	**11-15 years**	**16+**	Response Totals
yes (go to #2)	27.3% (3)	**55.6% (10)**	**63.2% (12)**	**65.0% (26)**	**58.0% (51)**
no (go to #20)	**63.6% (7)**	38.9% (7)	36.8% (7)	32.5% (13)	38.6% (34)
not sure (go to #20)	9.1% (1)	5.6% (1)	0.0% (0)	2.5% (1)	3.4% (3)
answered question	11	18	19	40	88
				skipped question	3

Fisher's Exact (6, N = 88): P = 0.125

Table 11: Knowledge of boosting in athletes' sport across educational levels in high level spinal injured athletes (N = 48 responses)

6. To your knowledge, would you say boosting is:

	What is the highest level of education you have completed?					
	high school graduation	some post-secondary (not university)	some university (not degree)	undergraduate university degree	graduate university degree	Response Totals
commonly used in your sport	12.5% (2)	33.3% (2)	**75.0% (3)**	20.0% (2)	**33.3% (4)**	27.1% (13)
infrequently used in your sport	**25.0% (4)**	16.7% (1)	0.0% (0)	20.0% (2)	25.0% (3)	20.8% (10)
rarely used in your sport	**25.0% (4)**	0.0% (0)	0.0% (0)	0.0% (0)	8.3% (1)	10.4% (5)
not used in your sport	12.5% (2)	0.0% (0)	0.0% (0)	0.0% (0)	8.3% (1)	6.3% (3)
I'm not sure of its use	**25.0% (4)**	**50.0% (3)**	25.0% (1)	**60.0% (6)**	25.0% (3)	**35.4% (17)**
answered question	16	6	4	10	12	48
					skipped question	31

Fisher's Exact (16, N = 48): P = 0.584

Table 12: Use of boosting in athletes' sport across injury duration in high level spinal injured athletes (N = 55 responses)

6. To your knowledge, would you say boosting is:

	For how many years have you had the spinal injury?				
	1-5 years	6-10 years	11-15 years	16+	Response Totals
commonly used in your sport	0.0% (0)	20.0% (2)	15.4% (2)	**41.4% (12)**	29.1% (16)
infrequently used in your sport	**66.7% (2)**	**30.0% (3)**	15.4% (2)	13.8% (4)	20.0% (11)
rarely used in your sport	33.3% (1)	20.0% (2)	7.7% (1)	13.8% (4)	14.5% (8)
not used in your sport	0.0% (0)	10.0% (1)	0.0% (0)	3.4% (1)	3.6% (2)
I'm not sure of its use	0.0% (0)	20.0% (2)	**61.5% (8)**	27.6% (8)	**32.7% (18)**
answered question	3	10	13	29	55
				skipped question	36

Fisher's Exact (12, N = 55): P = 0.217

Table 13: Opinion regarding dangers of boosting in male and female athletes with high level spinal injury (N = 57 responses)

11: Based on what you know about *boosting*, would you say it is:

	Please check the appropriate box for each of the following items.		
	female	male	Response Totals
not at all dangerous	0.0% (0)	5.8% (3)	5.3% (3)
somewhat dangerous	**80.0% (4)**	**46.2% (24)**	**49.1% (28)**
dangerous	0.0% (0)	23.1% (12)	21.1% (12)
very dangerous	20.0% (1)	25.0% (13)	24.6% (14)
answered question	5	52	57
		skipped question	38

Fisher's Exact (3, N = 57): P = 0.615

Table 14: Knowledge of the dangers of boosting across education levels in athletes with high level spinal injury (N = 47 responses)

11: Based on what you know about *boosting*, would you say it is:

	What is the highest level of education you have completed?					
	high school graduation	some post-secondary (not university)	some university (not degree)	undergraduate university degree	graduate university degree	Response Totals
not at all dangerous	7.7% (1)	0.0% (0)	0.0% (0)	10.0% (1)	0.0% (0)	4.3% (2)
somewhat dangerous	**38.5% (5)**	40.0% (2)	16.7% (1)	**80.0% (8)**	**53.8% (7)**	**48.9% (23)**
dangerous	15.4% (2)	**60.0% (3)**	33.3% (2)	0.0% (0)	23.1% (3)	21.3% (10)
very dangerous	**38.5% (5)**	0.0% (0)	**50.0% (3)**	10.0% (1)	23.1% (3)	25.5% (12)
answered question	13	5	6	10	13	**47**
					skipped question	**32**

Fisher's Exact (12, N = 47): P = 0.106

Table 15: Knowledge of dangers of boosting across injury duration in athletes with high level spinal injury (N = 54 responses)

11: Based on what you know about *boosting*, would you say it is:

	For how many years have you had the spinal injury?				
	1-5 years	6-10 years	11-15 years	16+	Response Totals
not at all dangerous	0.0% (0)	9.1% (1)	7.1% (1)	3.8% (1)	5.6% (3)
somewhat dangerous	33.3% (1)	**45.5% (5)**	**71.4% (10)**	**42.3% (11)**	**50.0% (27)**
dangerous	0.0% (0)	27.3% (3)	14.3% (2)	19.2% (5)	18.5% (10)
very dangerous	**66.7% (2)**	18.2% (2)	7.1% (1)	34.6% (9)	25.9% (14)
answered question	3	11	14	26	**54**
				skipped question	37

Fisher's Exact (9, N = 54): P = 0.421

Table 16: Attitude towards boosting in male and female athletes with high level spinal injury (N = 61 responses)

14. With 1 being *totally not acceptable* and 5 being *totally acceptable*, please circle the number that best reflects your opinion about boosting.

		female	male	Response Totals
boosting to improve training capacity is	1	83.3% (5)	61.1% (33)	
	2	16.7% (1)	14.8% (8)	
	3	0.0% (0)	11.1% (6)	
	4	0.0% (0)	11.1% (6)	
	5	0.0% (0)	1.9% (1)	
		6	54	60
boosting to maximize performance in competition is	1	83.3% (5)	63.0% (34)	
	2	16.7% (1)	11.1% (6)	
	3	0.0% (0)	11.1% (6)	
	4	0.0% (0)	9.3% (5)	
	5	0.0% (0)	5.6% (3)	
		6	54	60
boosting because you know your competitors are boosting is	1	83.3% (5)	56.6% (30)	
	2	16.7% (1)	15.1% (8)	
	3	0.0% (0)	11.3% (6)	
	4	0.0% (0)	11.3% (6)	
	5	0.0% (0)	5.7% (3)	
		6	53	59
boosting is	1	83.3% (5)	58.2% (32)	
	2	16.7% (1)	12.7% (7)	
	3	0.0% (0)	12.7% (7)	
	4	0.0% (0)	10.9% (6)	
	5	0.0% (0)	5.5% (3)	
		6	55	61
answered question		6	55	61
			skipped question	34

Fisher's Exact (4, N = 61): P = 0.875

Table 17: Opinion about boosting across education levels in athletes with high level spinal injury (N = 51 responses)

14. With 1 being *totally not acceptable* and 5 being *totally acceptable*, please circle the number that best reflects your opinion about boosting.

		high school graduation	some post-secondary (not university)	some university (not degree)	undergraduate university degree	graduate university degree	Response Totals
boosting to improve training capacity is	1	81.3% (13)	28.6% (2)	60.0% (3)	50.0% (5)	66.7% (8)	
	2	0.0% (0)	57.1% (4)	20.0% (1)	20.0% (2)	16.7% (2)	
	3	6.3% (1)	14.3% (1)	0.0% (0)	20.0% (2)	0.0% (0)	
	4	6.3% (1)	0.0% (0)	20.0% (1)	10.0% (1)	16.7% (2)	
	5	6.3% (1)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	
		16	7	5	10	12	50
boosting to maximize performance in competition is	1	81.3% (13)	42.9% (3)	60.0% (3)	50.0% (5)	66.7% (8)	
	2	0.0% (0)	42.9% (3)	20.0% (1)	20.0% (2)	8.3% (1)	
	3	12.5% (2)	14.3% (1)	0.0% (0)	10.0% (1)	8.3% (1)	
	4	0.0% (0)	0.0% (0)	20.0% (1)	10.0% (1)	16.7% (2)	
	5	6.3% (1)	0.0% (0)	0.0% (0)	10.0% (1)	0.0% (0)	
		16	7	5	10	12	50
boosting because you know your competitors are boosting is	1	75.0% (12)	14.3% (1)	60.0% (3)	50.0% (5)	63.6% (7)	
	2	0.0% (0)	57.1% (4)	20.0% (1)	20.0% (2)	18.2% (2)	
	3	12.5% (2)	28.6% (2)	0.0% (0)	10.0% (1)	0.0% (0)	
	4	6.3% (1)	0.0% (0)	20.0% (1)	10.0% (1)	18.2% (2)	
	5	6.3% (1)	0.0% (0)	0.0% (0)	10.0% (1)	0.0% (0)	
		16	7	5	10	11	49
boosting is	1	75.0% (12)	42.9% (3)	60.0% (3)	40.0% (4)	61.5% (8)	
	2	0.0% (0)	57.1% (4)	20.0% (1)	20.0% (2)	7.7% (1)	
	3	12.5% (2)	0.0% (0)	0.0% (0)	20.0% (2)	15.4% (2)	
	4	6.3% (1)	0.0% (0)	20.0% (1)	10.0% (1)	15.4% (2)	
	5	6.3% (1)	0.0% (0)	0.0% (0)	10.0% (1)	0.0% (0)	
		16	7	5	10	13	51
answered question		16	7	5	10	13	51
						skipped question	28

Fisher's Exact (16, N = 51): P = 0.773

Table 18: Opinion about boosting across injury duration in athletes with high level spinal injury (N = 58 responses)

14. With 1 being *totally not acceptable* and 5 being *totally acceptable*, please circle the number that best reflects your opinion about boosting.

		1-5 years	6-10 years	11-15 years	16+	Response Totals
boosting to improve training capacity is	1	66.7% (2)	36.4% (4)	57.1% (8)	65.5% (19)	
	2	33.3% (1)	36.4% (4)	7.1% (1)	13.8% (4)	
	3	0.0% (0)	0.0% (0)	21.4% (3)	13.8% (4)	
	4	0.0% (0)	18.2% (2)	14.3% (2)	6.9% (2)	
	5	0.0% (0)	9.1% (1)	0.0% (0)	0.0% (0)	
		3	11	14	29	57
boosting to maximize performance in competition is	1	66.7% (2)	36.4% (4)	71.4% (10)	65.5% (19)	
	2	33.3% (1)	27.3% (3)	0.0% (0)	13.8% (4)	
	3	0.0% (0)	9.1% (1)	21.4% (3)	6.9% (2)	
	4	0.0% (0)	9.1% (1)	7.1% (1)	10.3% (3)	
	5	0.0% (0)	18.2% (2)	0.0% (0)	3.4% (1)	
		3	11	14	29	57
boosting because you know your competitors are boosting is	1	66.7% (2)	27.3% (3)	64.3% (9)	57.1% (16)	
	2	33.3% (1)	27.3% (3)	0.0% (0)	21.4% (6)	
	3	0.0% (0)	9.1% (1)	21.4% (3)	10.7% (3)	
	4	0.0% (0)	18.2% (2)	14.3% (2)	7.1% (2)	
	5	0.0% (0)	18.2% (2)	0.0% (0)	3.6% (1)	
		3	11	14	28	56
boosting is	1	66.7% (2)	27.3% (3)	64.3% (9)	63.3% (19)	
	2	33.3% (1)	27.3% (3)	0.0% (0)	16.7% (5)	
	3	0.0% (0)	9.1% (1)	28.6% (4)	6.7% (2)	
	4	0.0% (0)	18.2% (2)	7.1% (1)	10.0% (3)	
	5	0.0% (0)	18.2% (2)	0.0% (0)	3.3% (1)	
		3	11	14	30	58
answered question		3	11	14	30	58
					skipped question	33

Fishers Exact (12, N = 58): P = 0.793

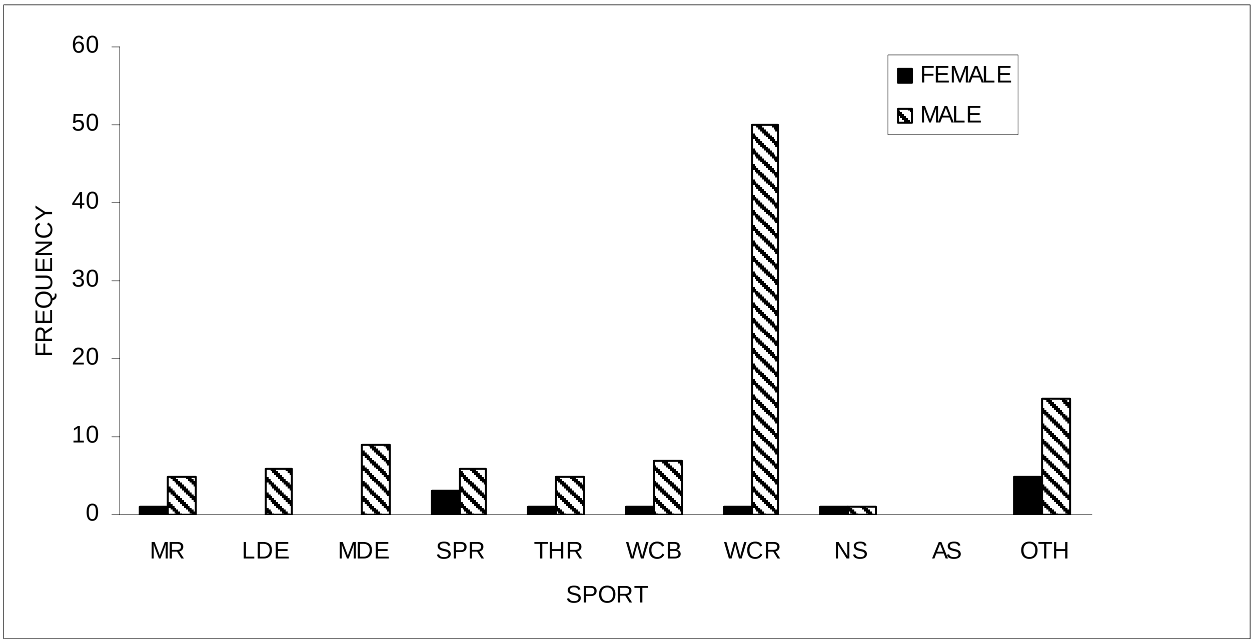


Figure 1: Frequency of sport participation in athletes with high level spinal cord injury (N = 99).
Legend: MR = marathon racing, LDE = long distance events, MDE = middle distance events, SPR = sprint races, THR = throwing events, WCB = wheelchair basketball, WCR = wheelchair rugby, NS = Nordic skiing, AS = Alpine skiing, OTH = other events.
Note: many athletes participated in more than one sport, and therefore, the total of all the frequencies exceeds 100%.

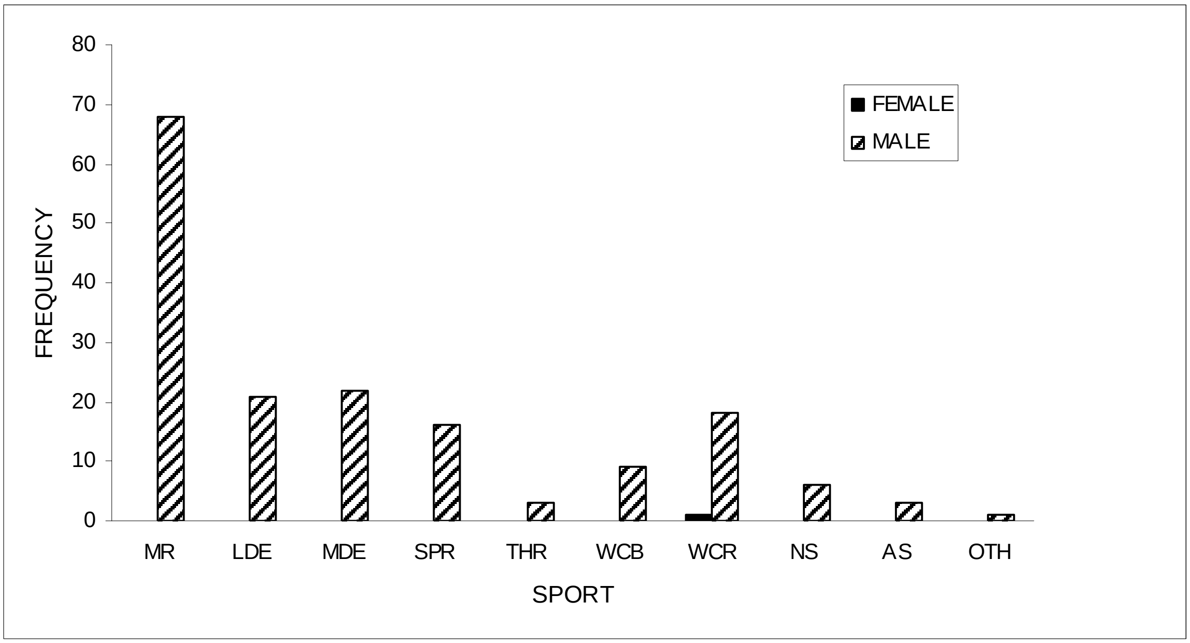


Figure 2: Events that will *most likely* be benefited by boosting in high level spinal injured athletes (N = 29 responses)

Legend: MR = marathon racing, LDE = long distance events, MDE = middle distance events, SPR = sprint races, THR = throwing events, WCB = wheelchair basketball, WCR = wheelchair rugby, NS = Nordic skiing, AS = Alpine skiing, OTH = other events.

Note: only one female participant responded to this question. Her response is illustrated in wheelchair rugby.

Note: many athletes participated in more than one sport, and therefore, the total of all the frequencies exceeds 100%.

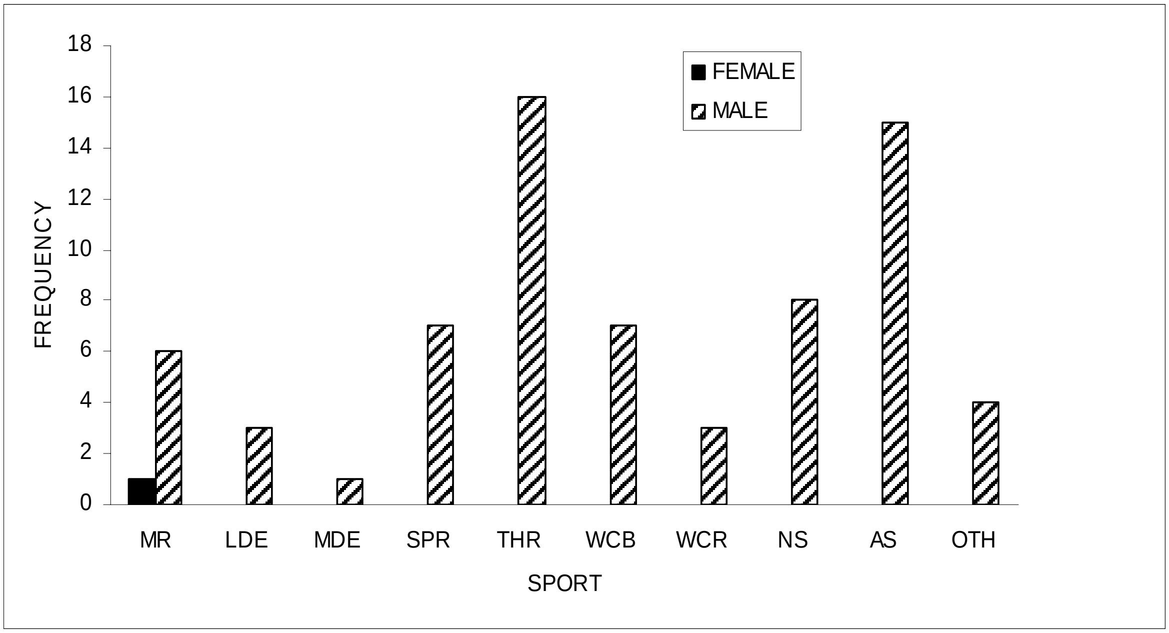


Figure 3: Events that will *least likely* be benefited by boosting in high level spinal injured athletes (N = 28 responses)

Legend: MR = marathon racing, LDE = long distance events, MDE = middle distance events, SPR = sprint races, THR = throwing events, WCB = wheelchair basketball, WCR = wheelchair rugby, NS = Nordic skiing, AS = Alpine skiing, OTH = other events.

Note: only one female participant responded to this question. Her response is illustrated in marathon racing.

Note: many athletes participated in more than one sport, and therefore, the total of all the frequencies exceeds 100%.

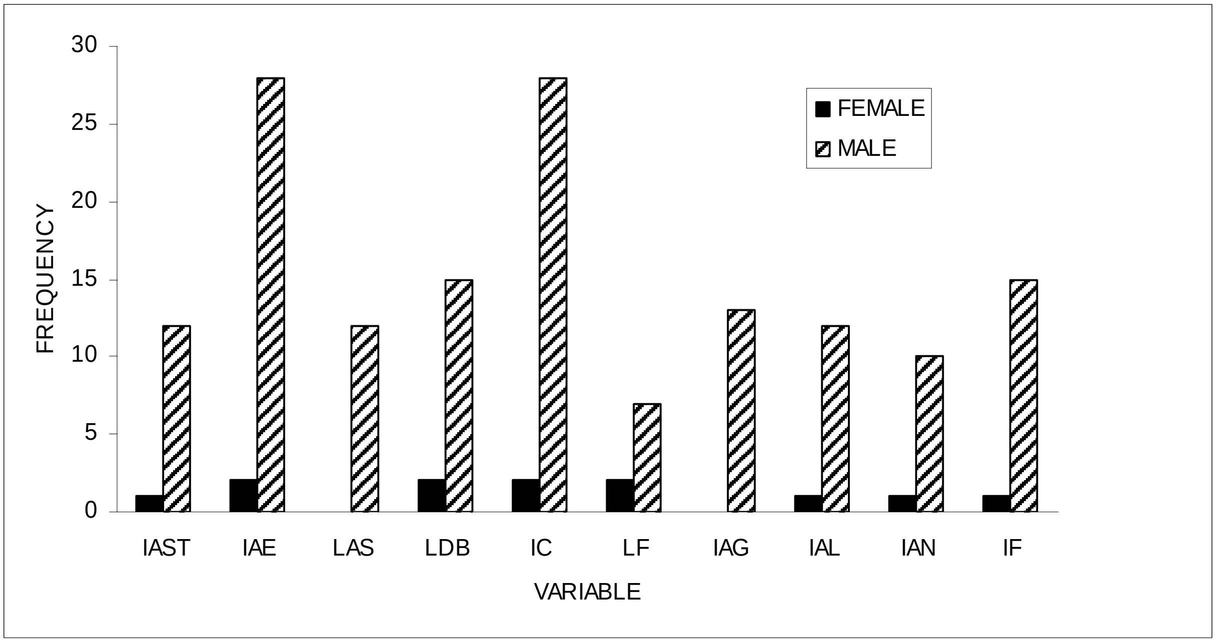


Figure 4: Variables that would benefit the most from boosting during competition (N = 50 responses)

Legend: IAST = increased arm strength, IAE = increased arm endurance, LAS = less arm stiffness, LDB = less difficulty breathing, IC = increased circulation, LF = less fatigue, IAG = increased aggression, IAL = increased alertness, IAN – increased anxiety, IF = increased frustration.

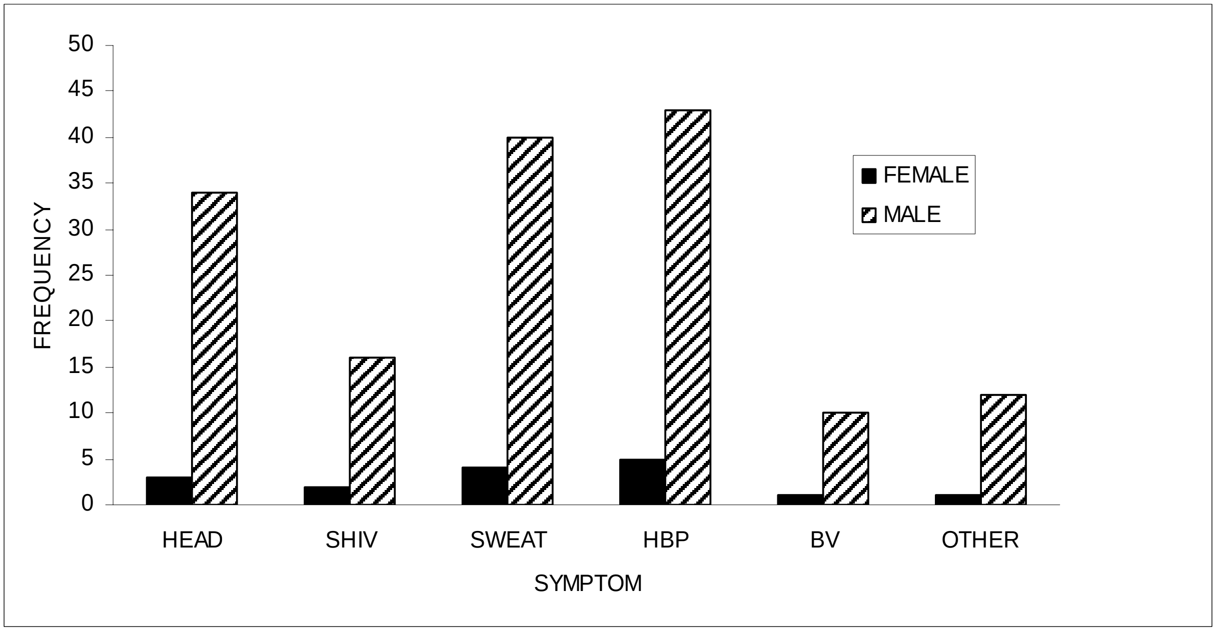


Figure 5: Symptoms of boosting reported by participants with high level spinal injuries (N = 58 responses)

Legend: HEAD = headache, SHIV = shivering, SWEAT = excessive sweating, HBP = high blood pressure, BV = blurred vision.

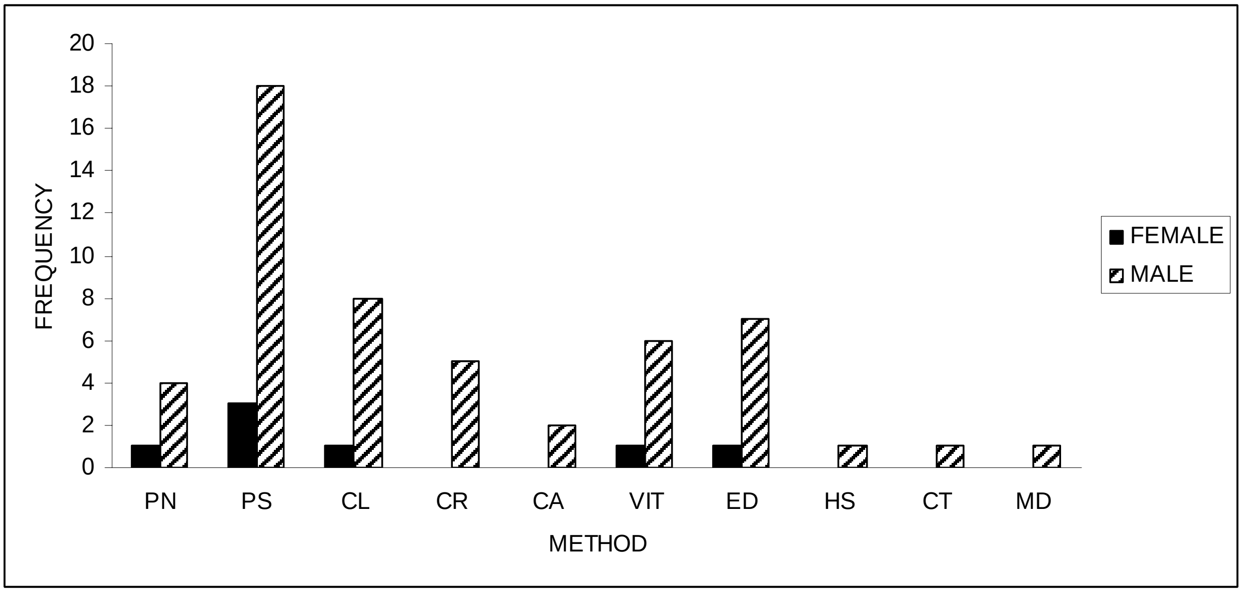


Figure 6: Methods of performance enhancement reported by participants with high level spinal injuries (N = 46 responses)

Legend: PN = proper nutrition, PS = protein supplementation, CL = carbohydrate loading, CR = creatine supplementation, CA = caffeine ingestion, VIT = vitamin supplements, ED = energy drinks, HS = herbal supplements, CT = climatic training, MD = medical doping.

Appendix G

Grammatically Edited Comments of Participants (N = 22)

Question: Is there anything else you would like to convey to the IPC about doping, boosting, or any other legal or banned performance enhancing strategy? If yes, please explain.

1. If boosting isn't controlled someone will die.
2. There is no way to control it from the outside if we can't control ourselves. I think is funny or stupid to even be asking about it.
3. I believe that from a clinical point of view, it is an advantage to have, but it does not improve my performance so I wouldn't do it.
4. Thanks for your effort to research the topic.
5. All forms of cheating should be banned.
6. Ban boosting. It's not natural to do that to your body. Just as doping is not natural.
7. If it is possible that all of the athletes can use boosting it will be good.
8. If it is possible that all athletes can use boosting it will be good and if it is not possible, boosting should be banned.
9. I think dysreflexia (boosting) is related to athlete's body and it can be used.
10. More testing.
11. No boosting – no doping.
12. It happens naturally for many of us when we need to urinate/empty bladder.
13. It is hard to monitor because many times it is involuntary.
14. I never heard about use of autonomic dysreflexia as doing, the paralympic sport is too young over here.
15. Anything legal to improve performance is acceptable, but the illegal aren't.
16. Don'n has fiscalization to verify the correct classification before and after the competition. The athlete uses the injury to benefit itself.
17. Ban all illegal activities. Do lots of doping tests. Give heavy penalties for doping.
18. I have only heard of track athletes doing this. Also it was a track athlete that told me about boosting. Prior to that I had never heard of it.

19. I think boosting is a kind of doping, but it is difficult to check during competition.
20. Your statement at the start that autonomic dysreflexia is experienced frequently is overstated but good luck in your moves to ban this activity.
21. There is very little control in African countries like South Africa; suggest the campaign starts at junior level.
22. I think it is difficult to check every time I have to pee. I have a little boost (I use a urine bag).