Neuropsychological test performance of Hawaii high school athletes: Hawaii ImPACT normative data

William T. Tsushima PhD, Ross Oshiro MS, and Daniel Zimbra BA

Abstract

Objective: Establishing normative data of the Immediate Post-Concussion Assessment and Cognitive Testing (ImPACT) test performance of high school athletes in Hawaii.

Study Design: Pre-season ImPACT testing was performed on 751 participants in football, baseball, basketball, soccer, volleyball, softball, and track from four Oahu public high schools. The ImPACT composite scores included measures of Verbal Memory, Visual Memory, Processing Speed, and Reaction Time. The descriptive statistical data collected were the group means, standard deviations, standard errors of measurement, distribution of scores and percentile ranks of (1) 262 boys ages 13 to 15; (2) 297 boys ages 16 to 18; and (3) 192 girls ages 13 to 18.

Results: The means and standard deviations of the four ImPACT composite scores for the 751 student-athletes in Hawaii were similar to the ImPACT scores obtained from a master database of ImPACT test results. Although differences between the Hawaii and mainland data were nonsignificant, there appeared to be a trend revealing somewhat lower scores in the Hawaii sample of athletes.

Discussion: The similarity in ImPACT test performance of Hawaii high school athletes as compared to the mainland normative data provides support for the applicability of this computerized neuropsychological battery in Hawaii. However, in view of a trend reflecting slightly lower ImPACT scores among Hawaii participants, the use of the normative data produced by this study may be desirable in assessing Hawaii high school athletes.

Introduction

The diagnosis and treatment of head injuries sustained in athletic activities have drawn increasing attention in recent years. Annually an estimated 300,000 mild traumatic brain injuries (MTBI) occur in sports events.[1] At the high school level alone, an estimated 62,000 varsity athletes sustain an MTBI each year, about 63% being football players.[2] The obvious seriousness of the impact of closed head injuries, such as impaired cognitive and emotional functioning, calls for improved methods of assessing the neuropsychological sequelae of sports-related concussions.

In the late 1990s, researchers at the University of Pittsburgh Medical Center, as part of their work with the Pittsburgh Steelers football team concussion program, developed a reliable, sensitive and practical approach to the neuropsychological assessment of MTBI. Instead of the labor intensive conventional paper-and-pencil neuropsychological test instruments, the research team constructed a computerized neurocognitive assessment method, referred to as ImPACT (Immediate Post-Concussion Assessment and Cognitive Testing) that evaluates verbal and visual memory, processing speed and reaction time.[3] Computerized neuropsychological testing provides a relatively brief (20 to 30 minutes), cost-efficient evaluation with clinically useful information for the management of head injured athletes.

A growing body of research attests to the reliability and validity of ImPACT in the neuropsychological evaluation of sports-related concussion.[4 - 6] Currently, ImPACT is utilized by over 125 Division I-A and I-AA colleges, over 300 high schools across the country, as well as the majority of National Football League teams, and professional motor sports participants.[7]

Several high schools in Hawaii have begun to utilize the ImPACT neuropsychological test battery, employing the descriptive statistics recommended by the authors.[8, 9] The present use of the ImPACT presumes that the statistical data and norms obtained by the test developers are applicable to all high school athletes in the United States, as research to challenge this presumption is non-existent. Indeed, despite the growing number of research report on the ImPACT, the influence of factors such as

geographic region or ethnic minority membership on ImPACT test performance has not, to date, been examined.

A number of studies have demonstrated that ethnic minority individuals score more poorly on cognitive tests,[10, 11] although the specific effects of culture and bilingualism on standardized tests scores are not clearly understood.[12] Thus, when such scores are relied upon to infer neuropsychological impairment in a minority person based on inappropriate norms, the consequence could be an overestimate of cognitive deficits.[13, 14] In sports, false positive errors may result in loss of valuable game time, possible harm to college scholarship opportunities, and emotional losses for the student-athlete.

The athletes in Hawaii high schools represent a racially diverse Pacific Islander population, including Caucasians, Polynesians, and Asians, as well as Hispanics and African Americans. Normative data that reflect the unique racial, ethnic and cultural backgrounds of the Hawaii population would appear to be a more relevant reference source than statistical data obtained on the mainland U.S.

In 1997 a panel of neurologists and neuropsychologists convened to address issues in sports-related concussion. The panel specifically promoted the establishment of databases for neuropsychological assessments instruments, like ImPACT, and further recommended the investigation of the effect of culturl factors on the neuropsychological test performances of school athletes.[15] The purpose of this research is to establish Hawaii-based norms by analyzing the ImPACT scores of student-athletes from four Oahu public high schools. Present interpretation of ImPACT test results in Hawaii assumes that scores obtained with a Pacific Islander population are comparable to data from the

present national normative sample. If the Hawaii ImPACT data deviate from the national norms, then the use of normative standards developed by this research should be considered when interpreting the ImPACT scores of Hawaii high school athletes.

Methods

Participants

The study, in a retrospective archival search, obtained the ImPACT test results of 751 consecutive student-athletes (559 boys, 192 girls), who were healthy at the time of their testing. The athletes were from four public high schools on Oahu.

The average age of the total sample was 15.91 years (SD=2.04). 207 (27.6%) of the subjects reported at least one previous concussion. The largest portion of the athletes was football players (47.9%). Other represented sports included basketball (8.4%), baseball (4.1%), soccer (0.8%), softball (0.3%), track (0.8%), volleyball (0.7%), wrestling (9.7%), and "others" (3.6%).

The student-athletes completed an average of 9.40 years (SD=1.96) of education.

For this study, the participants were placed in the following three groups: Boys ages 13 to 15, Boys ages 16 to 18, and Girls ages 13 to 18. The mean age of each group was Boys 13-15 (M=14.73, SD=1.78), Boys ages 16-18 (M=16.87, SD=1.39, and Girls 13-18 (M=15.99, SD=2.6). The mean years of education of each group were 8.42 (SD=1.59), 10.32 (SD=1.82), and 9.47 (SD=2.02), respectively.

Materials and Procedure

The participants were administered the IMPACT neuropsychological test battery[3] as part of an ongoing program establishing baseline or pre-injury neuropsychological test data to assist the athletic department staff in making return-to-play decisions after the

occurrence of a sports-related concussion. Data were also collected regarding the athlete's concussion history.

The computerized neuropsychological test was administered to each athlete by an athlete trainer trained in the administration of ImPACT. Version 2.0 of IMPACT consists of six individual test modules that measure different cognitive abilities. The four standard ImPACT composite scores were used for this study, including Verbal Memory, Visual Memory, Processing Speed, and Reaction Time.

Statistics

Descriptive statistics including means, standard deviations, and standard error of measurement were obtained for each of the four ImPACT composite scores (Verbal Memory, Visual Memory, Processing Speed, and Reaction Time) for the three groups of athletes. In addition, the distribution and percentile ranks of the composite scores for each group were calculated.

Results

The means (and standard deviations) for each of the four ImPACT composite scores of the entire group of 728 athletes were as follows: Verbal Memory 82.49 (9.83), Visual Memory 70.49 (13.36), Processing Speed 34.94 (8.29), and Reaction Time 0.60 (0.10). These scores are very similar to those in the study by McClincy, Lovell, Pardini, Collins, and Spore,[5] who reported the following means (and standard deviations) of 104 athletes: Verbal Memory 85.75 (8.59), Visual Memory 74.04 (13.82), Processing Speed 35.05 (6.90), and Reaction Time 0.57 (0.08).

The means, standard deviations, and standard errors of measurement for the four ImPACT composite scores of each of the three subgroups of athletes are presented in Table 1.

The Impaired classification, defined as scores< 1.9 percentile rank, are presented in Table 2 for the present sample and the ImPACT normative sample. Almost without exception the Hawaii cutoff scores identifying "impaired" performances were lower than the cutoffs in the national normative sample. Thus, the classifying of "impaired" scores would vary, depending on the use of local norms versus norms obtained on the mainland.

Because of space considerations, the distribution and percentile ranks of the composite scores for the three groups of participants are not presented in this report, but can be made available by contacting the first author.

Discussion

The purpose of this research was to examine the test scores of ImPACT, a computerized neuropsychological test battery, when administered to high school athletes in Hawaii. The results revealed that the ImPACT composite scores of a large sample (n = 751) of Hawaii high school athletes were similar to those of mainland high school athletes (n = 424), and tentatively support the use of ImPACT in Hawaii high schools. The present findings were consistent with previous investigations in Hawaii assessing the applicability of widely used neuropsychological test batteries, the Halstead-Reitan Neuropsychological Battery and the Luria-Nebraska Neuropsychological Battery.[16, 17]

A trend revealing slightly lower ImPACT scores among Hawaii participants was not unexpected. Past research suggest that on many cognitive measures, ethnic minority individuals perform relatively poorly, and are much more likely to be misclassified as

impaired than are Caucasians. Using the lower cutoff scores from this study to identify an impaired (< 1.9 percentile rank) performance, there would be fewer athletes identified as impaired than if national cutoff scores were used. However, at his nascent stage of employing the ImPACT, it is probably prudent to consider both the national normative data along with the norms obtained in this research when evaluating a head-injured Hawaii student-athlete.

Discussion of the implications of these results must consider the limitations in the data collected. The raw data from the mainland norms were not available, thus, a direct statistical comparison between ImPACT scores of the Hawaii participants and the mainland normative sample was not possible. At best, we were only able to make visual comparisons between the two sets of data, in which considerable similarity in ImPACT means and standard deviations was noted.

In this study, the Hawaii participants were grouped as a single sociocultural entity. A more informative investigation of the effects of ethnicity would identify subgroups of Pacific Islanders, such as those of Polynesian, Caucasian, Asian, African and Hispanic backgrounds, which was beyond the scope of the present research. The present study raises awareness that diversity is a significant factor in our country that needs to be considered when employing psychometric tests.

Computerized testing, like ImPACT, is useful as a quick, easy to administer neuropsychological measure of head trauma effects, but it is not a substitute for comprehensive neuropsychological testing that consists of a broad battery of test instruments and takes several hours of one-to-one examination. The proper use of ImPACT requires specialized training and experience in clinical neuropsychology, as

well as familiarity with the various ImPACT neuropsychological scores. Finally, it should be stressed that the proper evaluation of a head injured high school athlete involves an effective neuropsychological assessment within the context of a multidisciplinary effort headed by the team physician and including the athletic trainer, a neurological consultant, and other sources of clinical data, e.g., neurodiagnostic tests.

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Table 1

Means, standard deviations and standard errors of measurement of the three groups of athletes

	Boys 13-15			Boys 16-18			Girls 13-18		
	M	SD	SEM	M	SD	SEM	M	SD	SEM
Verbal Memory	80.66	10.29	0.64	81.93	11.71	0.68	84.98	8.59	0.62
Visual Memory	70.12	13.54	0.84	72.02	14.95	0.87	70.99	13.14	0.95
Processing Speed	31.18	8.39	0.52	34.83	9.21	0.54	35.35	7.52	0.54
Reaction Time	0.61	0.12	0.01	0.58	0.12	0.01	0.59	0.08	0.01

Table 2

Impaired classification cutoff scores for composite scores*

of the three groups of athletes

Age Groups	Verbal Memory		Visual Memory		Processing Speed		Reaction Time	
	Hawaii	Norms	Hawaii	Norms	Hawaii	Norms	Hawaii	Norms
Boys 13 to 15	≤57	≤63	≤45	≤49	≤13.6	≤16.2	≥.86	≥.76
Boys 16 to 18	≤55	≤68	≤37	≤51	≤10.2	≤26.4	≥.81	≥.74
Girls 13 to 18	≤68	≤68	≤43	≤49	≤19	≤18.9	≥.79	≥.75

*Impaired = < .19 percentile rank