ORIGINAL ARTICLE

Concussion in Hockey: Compliance with Return to Play Advice and Follow-up Status

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ABSTRACT: ***Objectives:*** To determine the compliance rate among hockey players with concussion or other head injuries who were advised by a physician about return to play. To assess compliance of hockey players with return to play advice and to assess the incidence of long-term post-concussion symptoms. ***Methods:*** A retrospective chart review, telephone questionnaire and follow-up analysis of income, level of education and professional aspirations. The study examined 40 hockey players with concussion or other head injury treated at a neurosurgical ambulatory clinic, who had initial visits between 1995 and 2003, and had been seen at least two years prior to completing the questionnaire. ***Results:*** There was a 58% (23 of 40) participation rate in the study. Fifteen (65%) of the 23 participants were advised to never return to play, and 5 (33%) were non-compliant and returned to play. Four (80%) of the five non-compliant players continued to suffer from post concussion symptoms. Overall, 15 (65%) of the 23 players participating in the study continued to suffer post concussion symptoms at least two years after the clinic visit. ***Conclusions:*** Five (33%) of 15 hockey players advised to never return to play were non-compliant and returned to play, and four continued to suffer from post concussion symptoms two or more years later. After repeated concussions, 65% of hockey players had long-term sequelae that prevented return to play and produced long-term post-concussion symptoms.

RÉSUMÉ: Commotion cérébrale au hockey : observance des recommandations sur le retour au jeu et état clinique au suivi. ***Objectifs :*** Le but de l'étude était de déterminer le taux d'observance des recommandations d'un médecin au sujet du retour au jeu chez des joueurs de hockey qui avaient subi une commotion cérébrale ou un autre traumatisme crânien, ainsi que d'évaluer le lien entre l'observance des recommandations et l'incidence de symptômes post-commotion cérébrale à long terme. ***Méthodes :*** Nous avons procédé à une revue rétrospective de dossiers, à un questionnaire téléphonique et à une analyse du suivi concernant le revenu, le niveau de scolarité et les aspirations professionnelles. L'étude a porté sur 40 joueurs de hockey qui avaient subi une commotion cérébrale ou un autre traumatisme crânien et qui avaient été traités à une clinique ambulatoire neurochirurgicale. La première visite avait eu lieu entre 1995 et 2003 et ils avaient été vus au moins deux ans avant de compléter le questionnaire. ***Résultats :*** Le taux de participation a été de 58% (23 sur 40). La recommandation chez 15 des 23 participants (65%) était de ne jamais retourner au jeu. Cinq d'entre eux (33%) n'ont pas observé cette recommandation et sont retournés au jeu. Des symptômes post-commotion cérébrale ont persisté au moins deux ans après leur visite à la clinique chez 4 de ces 5 joueurs (80%). Au total, des symptômes post-commotion cérébrale ont persisté chez 15 des 23 joueurs (65%) qui ont participé à l'étude. ***Conclusions :*** Cinq des 15 joueurs de hockey (33%) à qui on avait recommandé de ne jamais retourner au jeu n'ont pas observé cette recommandation et sont retournés au jeu et 4 d'entre eux ont continué à présenter des symptômes post-commotion cérébrale 2 ans ou plus après l'événement. Après plusieurs commotions cérébrales, 65% des joueurs de hockey présentaient des séquelles à long terme qui les empêchaient de retourner au jeu et qui causaient des symptômes post-commotion cérébrale.

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In 2003, it was reported that the annual concussion rate in the National Hockey League (NHL) in the previous five years had tripled compared to the previous decade[1]. At the elite level of hockey, there are many possible explanations for this increase including bigger and faster players, harder and less yielding boards, equipment changes such as inflexible shoulder and elbow pads, increased recognition of concussion and improved reporting[1]. The return of athletes to play before complete resolution of concussion symptoms is of great concern because of the potential for permanent cognitive and other neurological deficits[2,3]. Lack of compliance with return to play advice, especially after repeated concussions can put athletes at risk of suffering subsequent concussions, permanent brain damage and lifelong disability[4,5]. In hockey, there is increasing concern about

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the long-term consequences of concussions, especially repeated concussions. Concussion, a type of mild traumatic brain injury results from rapid acceleration or deceleration forces exerted on the brain. Former definitions of concussion had significant shortcomings and have been replaced by "The Summary and Agreement Statement of the 2nd International Conference on Concussion in Sport, Prague 2004"[6]. The current definition states "Concussion typically results in the rapid onset of short-lived impairment of neurologic function that resolves spontaneously", "may or may not involve loss of consciousness", and can be categorized as simple or complex. The post-concussion syndrome (PCS) is a potentially debilitating outcome of concussion[3], the symptoms of which include feeling dazed, memory impairment (such as short or long term memory deficits, or slowed mental processing), headache, nausea, depression, tinnitus, confusion, poor coordination, irritability and poor attention span[3,7,8]. The most severe sequelae of concussion are the rare "second impact syndrome" that can cause death when a second mild traumatic brain injury follows a previous brain injury from which the athlete had not fully recovered[3,8,9], and permanent brain injury causing dementia or movement disorders indicative of extra-pyramidal damage[10].

Today, in dealing with sport concussions, physicians, coaches and trainers have access to improved criteria and guidelines for return/non-return to play[5,8,11]. For return to play after concussion, players must have no neurological deficits, and no neurological symptoms, at rest or after a series of graded exercises[3,4,7,11-13]. Factors underlying advice for permanent non-return to contact sports are multiple concussions sustained over a short period of time, increasing length of time to recover from concussion, persisting cognitive or other neurological deficits, and abnormalities on computerized tomographic (CT) scans or magnetic resonance (MR) imaging[5]. However, recommendations by physicians to withdraw from sport, either temporarily or permanently, may not be complied with by players. Athletes may ignore, minimize or hide their symptoms for a number of reasons including pressure to play from parents, teammates and coaches[3].

The present paper measures the compliance rate among hockey players with concussion who were advised by a neurosurgeon about return to play. This is the first study to examine compliance rates among hockey players with respect to return to play advice provided by a physician after referral to a neurosurgical clinic. The report also provides data on the persistence of post-concussion symptoms.

Methods

The study was approved by the University Health Network Research Ethics Board, Toronto, Ontario. The initial survey involved review of the medical records of 40 consecutive hockey players who sustained concussions in hockey and were referred to a neurosurgeon (CHT) for assessment. The patients were assessed in the neurosurgical clinic at the Toronto Western Hospital between 1995 and 2003. These years were chosen to allow adequate time for assessment of compliance and long-term follow up of at least two years after initial assessment. Post-Concussion Follow-Up Questionnaires (Appendix A) were completed at least two years after the initial visit to the clinic. All players were contacted by letter, and asked to participate. One athlete who sustained injuries in a combination of sports including hockey, rugby, and football was included. During the period of this study various concussion grading schemes and return to play guidelines were in use, mainly the Cantu[14], Colorado[15] and American Neurological Association guidelines[16], and a combination of these systems was used. It is now apparent that none of these systems was evidence-based , and they have now been superseded by the system advocated by the Vienna and Prague International Conferences on Concussion in Sport[4,6]. There were no direct benefits to the study participants, and there were no risks associated with participating in this study. All information provided by the athletes has remained confidential, and published results are coded to ensure anonymity.

Players were initially contacted by letter at their last known address. The letter included directions for participation in the study, the Post-Concussion Follow-Up Questionnaire, and a consent form. Due to address changes and/or moving from home, especially common among elite level players, only two players responded to the initial letter. The non-responders received a telephone call to update the players' contact information. Also, the National Hockey League Players Association (NHLPA) agreed to forward our introductory letter and consent form to the professional players at their current addresses. Players contacted by telephone were then sent the study documents described above, and after receipt of the consent, the telephone questionnaire was completed by one of the researchers (AA). Players unable to return the consent form due to being outside the country gave verbal consent by telephone. Completion of the questionnaires by telephone took 10-15 minutes. The questionnaires contained 14 questions covering the physician's management of the patient, patient compliance, subsequent concussions and their effects, and post-concussion symptoms still being experienced (Appendix A). Questions were included about level of income and education, and professional hockey aspirations at the time of the concussion that precipitated referral to the neurosurgical clinic. One hearing impaired participant was unable to conduct the telephone interview, and the questionnaire was completed with the assistance of his father (a certified hockey trainer).

Thus, the present study is a retrospective, longitudinal study to examine by questionnaire, hockey players' compliance with a physician's advice about return to play, and the presence of post-concussion symptoms. The criteria for recommending non-return to play have been published previously[5]. The most frequent reason was persistence of significant post-concussion symptoms. The questionnaires were analyzed using descriptive analysis. Descriptive statistics were generated to determine if the athletes complied with the advice of the treating physician, and to assess the extent of recovery.

Results

The Study Population

Twenty-three of the 40 (58%) players referred to the physician for concussion or other head injury sustained in hockey agreed to participate in the survey (Figure 1). There was only one player who explicitly refused to participate, and the other 16 non-participants could not be located due to changes of address. However, we do not know whether the non-participants received our letters or phone calls, and therefore, it is unknown

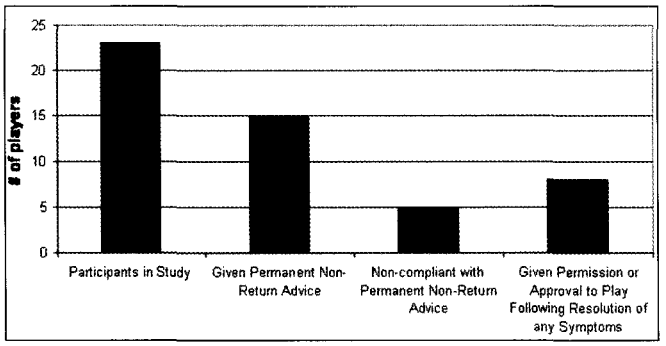

Figure 1: *Total number of participants in the study (n=23), the number given permanent non-return advice (15), the number of non-compliers (5), and the number given approval to return to play following resolution of any residual symptoms (8).*

if lack of contact meant refusal to participate. The attempt to contact six players through letters forwarded to them by the NHLPA, produced a response from one.

The 23 study participants included 22 males and 1 female with a mean age of 20 years, and a median age of 19 years at the time of their initial visits to the clinic. There were seven former or current professional hockey players who played either in Europe, the American Hockey League, or the National Hockey League. One current NHL player and two retired former NHL players were included. The other 16 players were at a variety of elite levels including the Canadian National Team, university teams in Canada or the USA, or in junior hockey leagues including the Ontario Hockey League and the Greater Toronto Hockey League.

Concussion History of the 23 Players

The players in this study were a unique population of concussed athletes with severe outcomes. All players required referral by another physician, and most were referred by family physicians. Prior to the clinic visit the players had sustained an average of 3.9 concussions. One player had nine prior concussions, three had eight concussions, one had seven concussions, three had five concussions, two had four concussions, five had three concussions, three had two concussions, and three players had only one concussion. We reclassified the concussions retrospectively based on the Prague Conference Guidelines on Concussion in Sport[4,6]. Of the 23 participants in the study, 22 had complex concussions, while only one had a simple concussion.

With respect to diagnostic imaging, 20 of the 23 participants had at least one type of imaging. Magnetic resonance imaging (MRI) was performed in 20 participants, and eight also had a CT scan. All reports were normal, except in three cases. One patient showed bifrontal contusions and a skull fracture, another showed an incidental type I Chiari malformation, and the last patient had a MRI showing two small areas of iron or calcium deposition, most likely due to small intracerebral hemorrhages.

Socioeconomic Status and Aspirations

The determination of socioeconomic status was based on two questions in the questionnaire: current salary; and highest current level of education. In our sample (n=23), we found that 65% of the players had or were in the midst of completing an undergraduate degree or higher. An additional 13% attended community college, and the remaining 22% had obtained a high school diploma. Thus, every participant had at least obtained a high school diploma. The annual income in Canadian dollars of the 23 participants showed that 9% earned $100,000 or more, 13% earned $61,000-$100,000, 35% earned $31,000-$60,000, and 9% earned $30,000 or below. Eight (34%) of the 23 were currently students, in either a community college or university.

The questionnaire asked about the players' aspirations with respect to a hockey career at the time of the initial clinic visit: 23% were amateurs with no professional aspirations; 54% were amateur players with aspirations to become professional hockey players; and 23% were professional hockey players with aspirations to continue professional play.

Hockey Return to Play Advice and Compliance

At the first or subsequent clinic visit, 15 (65%) of the 23 players were advised to give up all forms of hockey and other contact sports on a permanent basis, and we have labeled this as permanent non-return advice, and five (33%) of the 15 were non-compliant (Figure 1). Of the five non-compliant players, all five returned to non-contact hockey and three returned to contact hockey. Explanations provided by the players for non-compliant return included perceived pressure from the team, self-assumed recovery and readiness to play, and because they "missed playing the game". The other eight (35%) of the 23 players were permitted to return to play contact hockey after all symptoms had subsided (Figure 1). Six (75%) of these eight were compliant with the physician's advice to wait for complete resolution of symptoms. Of the six players who waited the appropriate time until complete resolution of symptoms, five (83%) had another concussion after returning to play, all but one in hockey (the other due to an altercation, unrelated to sports). Of the two players who returned earlier than advised, one was unable to continue to participate because of dizziness and the other player had at least two further concussions while playing hockey.

Impact of Concussions on Social and Professional Life

In answer to the question about what areas of their lives were affected by the concussions, 43% of the 23 players had difficulties at work, 52% had difficulties at school, 39% had difficulties playing organized hockey, and 61% had difficulties playing other sports (Figure 2). Other descriptions of the impact of the concussions included difficulty concentrating, photophobia, and impaired cognitive function. Many players switched to other activities to remain active and decrease the chance of a subsequent concussion. Fifteen (65%) of the 23 respondents were still playing non-contact hockey at the time the questionnaires were completed.

Post-Concussion Syndrome

Players were asked whether they still suffered from post-concussion syndrome at the time of the telephone interview. As

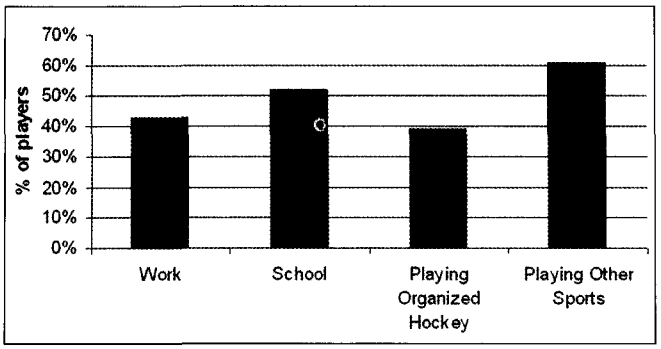

Figure 2: The activities affected by the players' concussions. Players could pick more than one category (n=23).

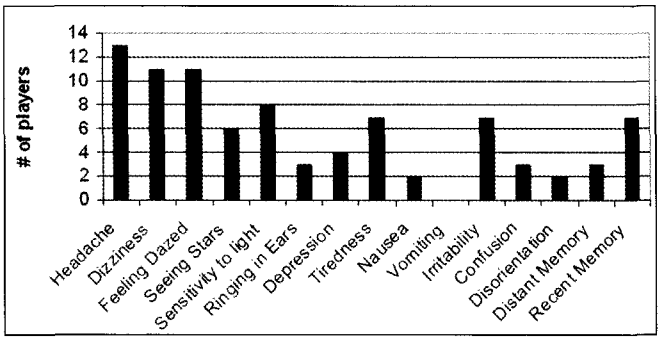

Figure 3: The players post concussion symptoms at the time of the telephone questionnaire at least two years after the physician consultation (n=15). Players could choose more than one category.

indicated above, all questionnaires were completed at least two years after the physician consultation, indicating that any residual symptoms had persisted for at least two years. Of the 23 respondents, 15 (65%) still suffered from PCS. Four (80%) of the five patients who disregarded the physician's advice to quit permanently continued to suffer from PCS. Of the 15 players who continued to suffer from PCS, all had multiple symptoms, and a large proportion suffered from headaches, dizziness, and feeling dazed, and many had continuing emotional, physical, and cognitive dysfunction (Figure 3).

Subsequent Concussions

Twelve (52%) of the 23 respondents reported suffering at least one subsequent concussion after the neurosurgical consultation, and the number of subsequent concussions ranged from one to five with a mean of 2.1 per player. Of the 12 players with a subsequent concussion, two (17%) returned to play earlier than advised and eight (67%) continued to suffer from PCS at the time of the telephone interview. The symptoms of PCS were similar to the initial concussion symptoms (Figure 4). Ten (83%) of the 12 with subsequent concussion sought additional treatment from another physician, and the majority were still suffering from the subsequent concussion at the time of the telephone questionnaire at least two years later. Most of the subsequent concussions were in hockey, although one former player was struck in the head by a puck while coaching a hockey game. There was one each in basketball, skiing, soccer, and a non-sports related altercation.

Discussion

There is continuing concern about the incidence, diagnosis and treatment of concussions in hockey players at all levels of ability. There has been progress in defining concussions and in developing more reliable guidelines for return to play after concussion. Furthermore, considerable effort has been made in knowledge translation with respect to informing players, trainers, coaches, leagues and the general public about current management of concussion and other head injuries. The aim has been to prevent long term sequelae such as dementia that can follow repeated blows to the head. A study of elite level hockey players found that concussion was the greatest cause of lost time to a hockey player, and that concussion was an increasing concern in the sport[17]. Increased speed and contact are increasing the frequency and severity of concussion in hockey[18]. One study of a Canadian junior hockey league reported between 4.6 and 5.9 concussions per 1000 player/game hours with the average age of approximately 15 at the time of the first hockey-related concussion. The predominant causes of concussion were contact with the ice and/or the boards, and elbowing[18].

The present study, to our knowledge, is the first to examine compliance of hockey players with physician generated advice about return to play after concussion. We attribute the high participation rate of 23 (58%) out of 40 possible participants to our follow-up by telephone after our initial letter. We placed calls to many locations in North America and Europe to reach participants. Once players were located, most wanted to participate, with only one refusal once participants were reached by telephone.

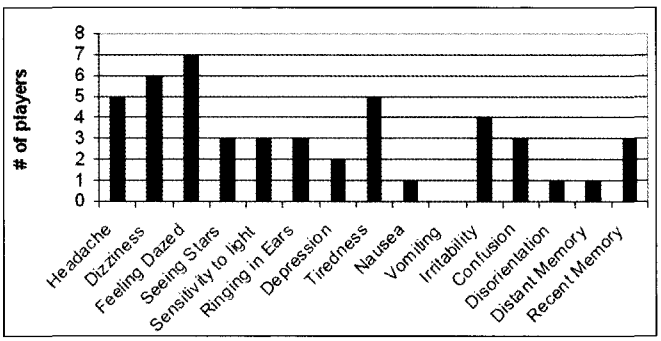

Figure 4: Subsequent post concussion symptoms in the players (n=12) who had repeat concussions. Players could choose more than one category.

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We acknowledge that our conclusions are observations based on a unique group of concussed hockey players referred to the Toronto Western Hospital neurosurgical clinic. Most were elite athletes referred for consultation, and all had already seen at least one physician for concussion management. Twenty-two of the 23 participants were classified as having "complex" concussion with an average of 3.9 concussions before referral.

Fifteen (65%) of the 23 participants were given permanent non-return to play advice, five (33%) were non-compliant and returned to play. Four (80%) of those five continued to suffer from post concussion symptoms at least two years later. Indeed, 65% of the total group of 23 hockey players had long-term sequelae that affected their ability to return to play and produced long-term post-concussion symptoms. Thus, it is not absolutely certain that non-compliance led to a higher incidence of sequelae. It remains for subsequent studies to answer this question.

It is of considerable concern that even when compliant, five (83%) of the six players had another concussion, perhaps because they were more susceptible to subsequent injury, even when they complied with the recommended delay until return to play.

A recent study examined the reporting of concussions, and found that concussions were heavily underreported to the league by hockey players and volunteers compared with official game reports[19]. The Greater Toronto Hockey League recently implemented a rule requiring a concussed player to have physician approval in writing before allowing return to play. This rule may diminish the peer pressure to return felt by the player, and also removes the responsibility for return to play decisions from the player, parent, coach, trainer and the league, and delegates this responsibility to physicians. Both elite and non-elite players may lie about symptoms in order to be cleared to play. In our study, 23% of the athletes played professionally and another 54% had aspirations to play at the professional level. Their drive to achieve likely influenced some of them to conceal symptoms or fail to disclose their diagnoses. Although standardization of mental status testing may improve determination of return to play readiness after concussion[20,21], there is no data about improvement in player compliance with physicians' recommendations regarding return to play based on cognitive testing.

Concussions can have major effects on a person's quality of life. Our respondents reported difficulties at work, attending school, playing organized hockey and playing other sports. Other sports included simple activities such as riding a stationary bicycle, lifting weights or even light running on a treadmill. In our study, 65% of the athletes continued to suffer from PCS two or more years after the consultation. Additionally, 65% of the players were told to stop playing hockey permanently and four (80%) of five players who did not follow this advice had PCS. The long-term persistence of PCS that we demonstrated is important because it indicates that the damaging effects of concussions were often not recognized early enough to prevent PCS and permanent brain damage. Physicians, trainers, coaches, players, parents and leagues must establish early recognition protocols to prevent permanent brain damage.

Twelve (52%) of the 23 players had at least one additional concussion after the consultation at the neurosurgical clinic. The majority of subsequent concussions were the result of hockey, although the hockey players also appeared to be more susceptible to concussions in other activities as well. Thus, physicians should encourage hockey players who have had repeated concussion to participate in sports with low risk for subsequent head injury.

The results of this study indicate that further work is required on concussion education and compliance among hockey players, and that additional measures are required to improve compliance[22,23]. For example, would compliance with return to play advice be enhanced by requiring written approval by a physician of a player's readiness to return?

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Appendix A: Hockey Concussion Survey

1. What was the diagnosis that I gave you about your head injury?
2. What management did I recommend for your injury, concerning return to play?
3. a. If I advised you to wait a period of time before returning to play, did you follow my advice? ☐ Yes ☐ No
   b. If your answer is no, please explain?
4. a. Did you return to play earlier than you were advised to? ☐ Yes ☐ No
   b. If your answer is yes, please explain.
5. a. Did I advise you to permanently stop playing hockey or other contact sports? ☐ Yes ☐ No
   b. If I advised you to permanently stop playing hockey or other contact sports, did you follow my advice? ☐ Yes ☐ No
   c. If your answer is no, please explain?
6. a. Do you continue to experience symptoms from the concussion for which you were assessed for by me? ☐ Yes ☐ No
   b. If so, which symptoms do you experience?
   ☐ Headache ☐ Dizziness
   ☐ Feeling dazed ☐ Seeing stars
   ☐ Sensitivity to light ☐ Ringing in ears
   ☐ Depression ☐ Tiredness
   ☐ Nausea ☐ Vomiting
   ☐ Irritability ☐ Confusion
   ☐ Disorientation ☐ Memory loss for remote events
   ☐ Memory loss for recent events
7. a. Did your concussion have an impact on your ability to:
   ☐ Work
   ☐ Go to school
   ☐ Play hockey (if you returned to play)
   ☐ Play other sports (please list)
   ☐ N/A
   ☐ Other _____
   b. If your answer is yes, please explain.
8. a. Have you experienced any subsequent concussions since your last visit to me? ☐ Yes ☐ No
   b. If so, how many? _____
   c. When were you injured?
   d. How did the concussion(s) occur?
   e. Did you seek treatment for the concussion(s)? (only if Yes to 8a) ☐ Yes ☐ No
   f. What was the advice that you received? (only if Yes to 8a)
9. a. If you had any subsequent concussions, did you return to play earlier than you were advised to? ☐ Yes ☐ No
   b. If your answer is yes, please explain?
10. a. If you had any subsequent concussions, do you continue to experience symptoms at the present time from the subsequent concussion(s) that you were assessed for? ☐ Yes ☐ No
    b. If so, which symptoms do you experience?
    ☐ Headache ☐ Dizziness
    ☐ Feeling dazed ☐ Seeing stars
    ☐ Sensitivity to light ☐ Ringing in ears
    ☐ Depression ☐ Tiredness
    ☐ Nausea ☐ Vomiting
    ☐ Irritability ☐ Confusion
    ☐ Disorientation ☐ Memory loss for remote events
    ☐ Memory loss for recent events
11. Are you currently:
    ☐ Working
    ☐ In school
    ☐ Playing hockey
    ☐ Playing other sports (please list)
    ☐ N/A
    ☐ Other _____
12. What level of education do you currently have?
    ☐ Grade 10 or lower
    ☐ High School
    ☐ Community College
    ☐ Undergraduate Degree or higher
    ☐ Other _____
13. What is your current yearly income (in Canadian dollars)?
    ☐ $30,000 or below
    ☐ $31,000-60,000
    ☐ $61,000-100,000
    ☐ $100,000 or above
14. At the time the physician advice was given to you, what was your hockey playing status and what were your hockey aspirations?
    ☐ An amateur player with no professional aspirations
    ☐ An amateur player with professional aspirations
    ☐ A professional player with aspirations to continue playing prof.
    ☐ Other_____

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