Risk Compensation

A "Side Effect" of Sport Injury Prevention?

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It is discouraging, to say the least, that countermeasures (e.g., protective equipment use) designed to lower the burden of injuries in sport and recreational activities do not warrant the same scientific scrutiny required in almost any other field of health research. New drug therapies require extensive research before they are adopted into medical practice. Yet there are countless examples of untested, unregulated countermeasures designed, albeit with good intentions, to lower the burden of injury in a particular sport or recreational setting. As William Haddon Jr. et al[1] so eloquently stated,

■ *One can, of course, argue that the introduction of essentially unevaluated accident prevention measures "can't do any harm," but two potential dangers in this approach need to be noted. First, the introduction and enforcement of insufficiently evaluated measures may lead to an inappropriate choice of emphasis and may, as a result, dissipate funds, time, and public concern that might be applied to more effective measures. Secondly, the public and its government may conclude that everything that can be done is being done.*

We would add that the possibility exists that the countermeasure in question may have other negative unintended consequences. These effects may include simply shifting the distribution of injury, a change in the behavior of participants resulting from a false sense of security, to reduced participation in the activity due to public discontent if the safety measure is imposed.

There are many examples in sport and recreation in which concern has been raised over the introduction of protective equipment. These include wrist guard use in snowboarding,[2] ski helmet use and risk of neck injury,[3,4] shoulder pad use in rugby,[5] and use of soft baseballs in Little League.[6,7] However, there are few compelling data to suggest the existence or absence of unintended effects.

RISK COMPENSATION

Some assert that protective equipment may prompt users to act more aggressively and thereby increase the potential for serious injury. This postulated phenomenon, referred to as *risk homeostasis* or *risk compensation*, hypothesizes that each person has a target level of risk they are willing to accept.[8] If a person perceives an intervention (e.g., helmet use) has lowered their level of risk, proponents of the theory argue users will change their behavior in a way that brings them back to their desired risk level (e.g., ski faster or more aggressively, on more difficult runs, through trees, or out of bounds).

Perhaps the greatest difficulty with the evidence for risk compensation is that much of it is ecologic; that is, there are few comprehensive examinations of individual risk-taking behavior before and after a safety measure is implemented. For example, increases in the rate of pedestrian injuries after the introduction of federal motor vehicle safety regulations

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were noted by proponents of the risk compensation hypothesis, despite several methodologic issues with the analysis of their data.[9]

What is the evidence for this phenomenon in the sport and recreation literature? The following examples describe some of the salient research in different activities that bears on the issue, but are not meant to be a comprehensive literature review. Perhaps the best place to begin is bicycle helmet use because it is such a contentious area of injury research.

Bicycle Helmet Use and Risk Compensation

Two studies on bicycle helmet use offer evidence that is incompatible with the risk compensation theory.[10,11] Farris et al[10] report that helmeted bicyclists were significantly more likely than nonhelmeted bicyclists to make legal stops and use standard hand signals to indicate a turn or stop. A study by Spaite et al[11] compared the non–head-neck injury severity among helmeted and nonhelmeted bicyclists presenting to an emergency department for treatment. These investigators reported that nonhelmeted bicyclists were over 7 times as likely to sustain major trauma, defined as an Injury Severity Score greater than 15, compared with helmeted bicyclists. Together, these studies indicate that helmeted bicyclists may represent a more cautious subgroup of all bicyclists. But even if they were risk compensating, it suggests that helmet wearers were not doing so to a level that increased their risk above that ob bicyclists not using helmets.

American Football and Risk Compensation

The plastic shelled helmet was introduced toward the end of the 1940s in American football.[12] Players were taught that the initial point of contact when tackling should be the shoulder. In the early 1960s, however, there was a move to make the initial point of contact the head because of the protection afforded by the helmet. There was a noted increase in the number of tackling drill fatalities over the period 1955 to 1964 compared with 1945 to 1954, persisting to 1974. Mueller suggested, "Players were wearing full face masks and felt well protected when striking their head."[12] After a rule change that abrogated spearing (i.e., initial contact with the head) in 1976, and the adoption of standards for football helmets in 1978, the number of head and cervical spine fatalities declined even in the face of an estimated increase in sport participation. If one attributes the increase in head and neck injury fatalities to the introduction of the football helmet and subsequently more dangerous participation, this example demonstrates that accompanying rule changes can counteract any compensatory effect.

Baseball and Risk Compensation

Pasternack et al[7] noted that the rate of injury for players using a soft-core baseball was actually higher compared with players using standard baseballs. This led to speculation that when using a soft-core baseball, "Children may be more likely to take a greater risk in fielding the ball or not moving away from a wild pitch if they believe that there is a decreased risk of injury."[6] This is alarming considering that the biomechanical data suggest that soft-core baseballs do not lower the risk of fatal chest impact injury over standard baseballs.[6]

Ice Hockey and Risk Compensation

Evidence for the effectiveness of ice hockey helmets in preventing brain injuries has been available since 1968.[13] Concern over the number of deaths in ice hockey in the late 1960s and early 1970s led to the adoption of a Canadian Standards Association standard for helmets in 1973.[14] Two concerns about hockey helmets were raised. The first was that due to a biomechanical mechanism, they may increase the risk of a neck injury. A biomechanical study suggested that this was not likely.[15] However, there was speculation that the use of a helmet may alter the nature of the game, "giving players such a feeling of invincibility that they take excessive and unwarranted risks during games and practices."[15]

Benson et al found evidence to suggest that players wearing half-face shields were 2.3 and 9.9 times more likely to sustain facial and dental injuries, respectively, compared with players wearing full-face shields.[15a] In fact, these investigators found evidence to suggest greater injury severity and a greater proportion of illegal play-related injuries among those wearing half shields. Stuart et al[16] noted similar findings among elite hockey players under age 18 years when they compared the rate of head, neck, and facial injury in full, partial, and no facial protection groups. The results of both studies run counter to what risk compensation would predict.

Rugby and Risk Compensation

The relatively recent introduction of protective equipment such as helmets and shoulder pads in various forms of rugby provides another opportunity to examine risk compensation. Finch et al[17] studied the attitudes of 140 rugby union players between the ages of 14 and 16 years toward the use of protective headgear. Interestingly, players with no prior head or neck injury were more likely to report that they felt safer wearing protective headgear compared with those with a prior injury. Further, of the players wearing protective headgear, 67% reported that they played with more confidence when they wore the headgear. The authors concluded that "players report that they are more confident and able to tackle harder if they wear headgear, suggesting that a belief in its protective capabilities may influence behavior."[17] This is particularly troublesome given that recent attempts at gauging the effect of protective headgear indicate that it is not effective at preventing concussion injuries in rugby union players under the age of 15 years.[18]

After finding a sharp increase in injury rates in rugby union, Garraway et al[19] contended that it might be due to the adoption of protective equipment and suggested, "The Inter-

national Rugby Board should place a moratorium on the use of protective equipment in competitive matches until its contribution to player morbidity has been fully assessed."

Skiing-Snowboarding and Risk Compensation

As long ago as 1962, Earle et al[20] reported on a series of ski injuries presenting to their Sun Valley medical clinic serving major ski hills in Idaho. The authors attempted to examine the effectiveness of safety bindings (multimode release bindings) and concluded that despite their use, injury rates remained unchanged through the 1950s—a time when they saw rapid increases in safety binding use. Although the authors acknowledged that the actual skiing time in 1960 to 1961 was likely greater than a decade earlier (increased skier exposure), they provide an interesting explanation why safety bindings did not lower the injury rate:

■ *. . .we wonder if wearing safety bindings may not lull the skier into a false sense of security. Thus, believing that he is protected, he skis with less caution and so deprives himself of whatever protection his release bindings may bestow. We believe that "safety binding" is an unfortunate term, which should be deleted from the skier's vocabulary.*[20]

In reports on skier fatalities, investigators generally state that the person died on a run at or below their ability level and that visibility was good.[21,22] This suggests skiers may modify their behavior in response to reduced environmental risk.

Findings of Shealy et al[23] that 35% of fatally injured skiers-snowboarders were wearing helmets support the theory of risk compensation. Helmet use estimates of uninjured populations are not typically close to 35%. Further, the circumstances surrounding the fatalities were consistent with extreme risk-taking behavior among those wearing helmets in 4 of the 6 cases in which the individual was wearing a helmet at the time of death. Whether the skiers increased their risk-taking behavior in response to wearing the helmet or they wore a helmet because they planned on taking greater risks is a subtle but important distinction with implications for the risk compensation theory.

Although far from convincing evidence, these mostly anecdotal reports and the speculation about a risk compensation effect cannot be ignored. Clear measures of this effect should be incorporated into any plan to evaluate protective equipment use in sport and recreational activities. Other possible consequences of mandating protective equipment should also be considered.

MANDATING USE

After 1 of the first rigorous studies of bicycle helmet effectiveness was published,[24] the debate began about the implementation of helmet laws. Arguments against mandatory use included the issues discussed here, but also involved societal level effects. Some investigators feared that mandatory helmet use would result in a net decrease in cyclists and the beneficial cardiovascular effects of cycling.[25] Although some evidence for this decline in ridership in adolescents after helmet laws was found in Australia, a recent Canadian study suggested no such effect.[26] The debate continues,[27,28] and all the reader can reasonably conclude is that more work is required.

SUMMARY

It was not our intention to offer an indictment of protective equipment in sport and recreation. Indeed, the evidence suggests that many of these devices do offer the individual a great deal of protection without deleterious effects. The issues presented here simply highlight the dire need for the early evaluation of protective equipment adopted in sport and recreation activities. Without examining the broad range of potential negative effects outlined here, it may indeed be the case that introducing well-intentioned countermeasures is more harmful than doing nothing. Only through well planned and executed studies can we evaluate the net benefit of our interventions and minimize the "side effects" of injury prevention strategies.

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