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Practitioner observations of oral nicotine use in elite

sport: You snus you lose

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ABSTRACT

The elite sport environment is one where athletes strive to find a competitive edge, through improved recovery modalities, cognitive performance or physical capacity. Due to this, non-scientifically evidenced and/or pseudo-scientific alternative remedies are ever popular. Snus (an oral tobacco based product containing the highly addictive compound nicotine) is one alternative ‘physical and psychological performance enhancer’, purported to act as a ‘mental and physical booster’, ‘relaxative’ and even as an ‘appetite suppressor’. Despite snus having

serious adverse health effects, along with no proven benefit to physical or mental performance, observations by the authors working in professional sport, along with several reports in the mainstream media, would suggest that the use of snus in elite sport appears to be increasing. Perhaps most worrying, the use of snus has been reported to be prevalent within younger athletes. It is crucial that athletes are fully educated with regards to the health implications of snus and other oral tobacco-based products, whilst practitioners should be aware of its growing prevalence in sport with strategies in place to discourage its use.

Key words: snuff, smoking, snusing, performance, health

THE ERGOGENIC EFFECTS OF NICOTINE

Nicotine is a stimulant which some athletes believe may enhance both physical and mental performance (Mündel, 2017a). This rapidly absorbed, highly addictive, parasymphomimetic alkaloid binds to neural nicotinic acetylcholine receptors (nAChRs) within the brain triggering the release of neuromediators (e.g. norepinephrine, epinephrine, acetylcholine, dopamine, serotonin, vasopressin, nitric oxide), causing a psychostimulant effect (Chague *et al.*, 2015; Pesta *et al.*, 2013). At higher doses, nicotine enhances the effect of serotonin leading to a 'calming' and 'depressing' effect (Pesta *et al.*, 2013; Silvette *et al.*, 1962). For more detail of the pharmacology and mechanisms of action of nicotine, readers are referred to Benowitz *et al.*, (2009).

There are numerous ways to administer nicotine such as inhalation, trans-dermally and orally. Snus is an oral tobacco-based product containing high levels of nicotine that originated in Sweden during the 18th century as a derivative of dry snuff. When nicotine is taken in the form of snus, the nicotine rapidly diffuses across the mucosal membrane into the bloodstream (Fant

et al., 1999) and has been reported to peak blood nicotine levels similarly to cigarette smoking (Holm *et al.*, 1992). Although modern day snus is reported to be manufactured with lower levels of toxicants than previously, there are still many confounding health issues associated with snus usage. The purpose of the current article (and accompanying graphic, see Figure 1) is to: 1) raise awareness of snus use in sport which has been observed directly by the authors in their daily practice, along with reports in the printed media (BBC Sport, 2018; Keegan, 2018a, 2018b; Wooler & Pollard, 2018) and scientific literature (Martinsen *et al.*, 2012; Mündel *et al.*, 2017a) especially in team sports such as football and rugby, 2) provide an overview of the potential ergogenic effects of nicotine with a specific focus upon snus and 3) briefly describe the health implications of snus.

PERFORMANCE IMPLICATIONS

Athletes claim that nicotine can help with xerostomia, weight control (through the suppression of appetite), improved concentration, enhanced reaction time and promotes relaxation (Mündel, 2017a). Despite the proposed benefits of nicotine to performance (Johnstone *et al.*, 2018a; Mündel *et al.*, 2006; Mündel *et al.*, 2017b; Pesta *et al.*, 2013; Tucha & Lange, 2004; West & Jarvis, 1986), other literature surrounding nicotine containing oral tobacco (such as snus) suggests that there are no beneficial (Druyan *et al.*, 2016; Duser & Raven, 1992; Fogt *et al.*, 2016; Mündel *et al.*, 2017b; Mündel *et al.*, 2019; Pysny *et al.*, 2015; Zandonai *et al.*, 2018b), and may be even detrimental effects (Druyan *et al.*, 2016; Escher *et al.*, 1998) on both aerobic and anaerobic performance. Indeed, this is similar within strength-based exercise, where research has shown no improvement and even detrimental effects on maximal voluntary contraction and maximal rate of force generation (Escher *et al.*, 1998; Morente-Sánchez *et al.*, 2015). In addition, there are limited data for positive cognitive effects of snus within non-habitual (nicotine naïve) snus using individuals (Johnston *et al.*, 2018b), and instead, snus at rest has been shown to reduce readiness to train whilst increasing mental fatigue (Morente-

Sánchez *et al.*, 2015) and may increase reaction times (Keenan *et al.*, 1989). Indeed, Morente-Sánchez *et al.*, (2015) observed participants being unable to complete testing due to side effects (including serious symptoms of confusion, dizziness, nausea, tiredness and tremors). The documented improvements in fatigue perception were in those habitually using snus, suggesting a ‘withdrawal relief’ effect, in this case a 12 h abstinence (Zandonai *et al.*, 2018a). Taken together, despite some athletes using snus as a potential ergogenic aid (Mündel, 2017a), to date there are limited data to indicate snus has any performance benefits for athletes, where in fact, the balance of evidence suggests snus has no effect or may even be detrimental to aerobic, anaerobic and strength based activities (Keenan *et al.*, 1989; Morente-Sánchez *et al.*, 2015; Mündel *et al.*, 2019; Van Duser & Raven, 1992; Zandonai *et al.*, 2018b). It is important, however, to stress that the extant literature base with regards to nicotine, and specifically snus is not only limited in the total number of published studies but also in the unique challenges of research in this field. Such challenges have been comprehensively reviewed (Mundel, 2018), and include, but not limited to, an individual’s tolerance and sensitivity to nicotine, difficulty in placebo controlling nicotine trials, an individual’s responses to nicotine especially their individual clearance rates, the delivery route of nicotine being used with very limited data on snus itself, and the health consequences / stigma of nicotine which will no doubt limit the number of researchers and indeed participants choosing to study this area. It is now crucial that well-designed, double blind, placebo controlled laboratory and field studies are performed on the ergogenic effects of nicotine (and particularly snus) to determine if snus is indeed ergogenic in a variety of specific populations.

HEALTH IMPLICATIONS

There is mixed epidemiological evidence surrounding the effect of snus on pancreatic cancer and oro-pharyngeal cancer risk (ranked #6 and #7 for cancer mortality rate in the UK), with

some arguments suggesting that snus is a lower risk alternative than smoking (Boffetta *et al.*, 2008; Farsalinos, 2019; Macara, 2008; Ramström, 2019; Rodu, 2007). Numerous articles have investigated the epidemiological links between differing types of cancer and use of snus (along with other oral tobaccos) again with equivocal results. It is beyond the scope of this article to fully review this literature, however, Cancer Research UK suggests that despite the evidence being equivocal, snus has been linked to some types of cancer, particularly pancreatic cancer (Luo *et al.*, 2007; Araghi *et al.*, 2017) and therefore its use should be discouraged. In addition to its proposed carcinogenetic properties, the use of snus may be detrimental to cardiovascular health (Isomaa *et al.*, 2001; Norberg *et al.*, 2006; Reaven, 1988) with an increased risk of type-2 diabetes (Carlsson *et al.*, 2017), hypertriglyceridemia (Wallenfeldt *et al.*, 2001), lowered ventricular threshold (Deligiannis *et al.*, 2006), elevated total cholesterol (Connolly *et al.*, 1988), depressed HDL (Connolly *et al.*, 1988), elevated plasma insulin levels (Eliasson *et al.*, 1991), increased coronary vasoconstriction (Cregler, 1999; Kaijser & Berglund, 1985; Piano *et al.*, 2010), impaired coronary blood flow (Crystal *et al.*, 1981; Kaijser & Berglund, 1985), and impaired endothelial function (Neunteufl *et al.*, 2002; Rohani & Agewall, 2004). There is strong evidence with regards to the detrimental effects of regular snus use on oral health and hygiene with strong links to periodontal disease (Odenbro *et al.*, 2005; Thomas *et al.*, 2003). Snus induced keratosis ('snuf-dipper' lesions) are found at the gum site where the bags are placed, with these being positively correlated with daily duration, consumption and historical use (Odenbro *et al.*, 2005; Thomas *et al.*, 2003). In addition to previous research finding a correlation between smokeless tobacco use and risk of injury in army conscripts (Heir *et al.*, 1997), physiological strain and heat intolerance has been observed to be significantly greater in nicotine users, potentially leading to a further increased risk of heat related injuries (Druyan *et al.*, 2016). Therefore, due to the numerous adverse health implications, athletes should not be considering this product as either an ergogenic aid or a recreational activity. Given the

addictive nature of snus and other tobacco based products, support should be provided to help athletes cease using such products and this will require transparent and judgment free conversations.

SNUS and WADA

Although not prohibited by WADA (World Anti-Doping Agency, 2020), nicotine was placed on the WADA monitoring programme in 2013 due to suggestions that its prevalence was increasing to enhance athletic performance (Pesta et al., 2013). The WADA prohibited list is based upon a product satisfying two of the following three criteria: 1) The *potential* to enhance performance 2) A potential risk to the health of the athlete 3) It violates the spirit of sport (World Anti-Doping Agency, 2020). Given the well documented adverse health effects of snus and the *potential* to enhance performance (although in our opinion the balance of evidence suggests there are no benefits to performance), along with WADA's own definition of what the spirit of sport is, it is hard to understand why snus and other tobacco based products are not currently prohibited. Future research must document the prevalence of snus and other oral tobacco use within athletic populations, assess the reasons why athletes are using snus and further examine the perceived performance enhancing benefits of snus. These data may be crucial in determining the WADA status of oral tobacco.

CALL FOR ACTION

Using the limited data currently available within athletic populations, it is estimated that 15-75% of athletes may be either habitual or previous oral nicotine users (Alaranta *et al.*, 2006; Conrad *et al.*, 2014; Gouttebauge *et al.*, 2016; Marclay *et al.*, 2011; Mundel, 2017; NCAA, 2018; Zandonai *et al.*, 2018a) with usage seemingly increasing. Although it has not been directly quantified, this alarmingly high percentage of nicotine users in athletic populations

could be largely from smokeless tobacco products given the well-reported adverse health and performance effects of smoking tobacco and the associated stigma of this in athletes. Indeed, in the authors own observations working in professional sport, snus use is now common with players openly using and sharing products in the elite environment. Of particular concern is the increase in snus use in the younger players due to perceived performance enhancement purposes. Considering the potential health consequences of snus we recommend that snus use in the elite sport environment is actively discouraged. Athletes must be fully educated on the risks to health whilst clearly pointing out that the balance of evidence suggests a performance detriment rather than performance enhancing effect of snus. Moreover, research should now be performed to examine the extent of snus use in a variety of sports, examine if the prevalence of use is indeed increasing as suggested in the popular media and the authors own observations, establish the common reasons why athletes are using snus and implement education strategies, especially with younger athletes who may be tempted to try such products. If research confirms that snus offers no performance benefits, it is crucial that athletes are made aware of this and encouraged to stop using it immediately (which may involve professional support if athletes have become addicted), however, if there is are proven performance benefits then WADA may need to come to the rescue to help us protect the health of our athletes.

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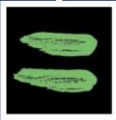









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PRACTITIONER OBSERVATIONS OF ORAL TOBACCO USE IN ELITE SPORT:

SNUS YOU LOSE



WHAT IS SNUS?	SNUS & PERFORMANCE	SNUS & HEALTH
<p> Snus is an oral tobacco product originating in Sweden containing nicotine and other toxins.</p> <p>Snus is not prohibited by WADA, however is currently on the WADA monitoring programme due to nicotine content.</p> <p></p> <p> The use of snus within sport is on the increase.</p>	<p>Literature suggests that there are no benefits of using snus on aerobic or anaerobic performance.</p> <p></p> <p>Snus may be detrimental to muscle force whilst nicotine may have negative effects on cognitive performance and resistance to fatigue.</p> <p></p> <p>Snus has been shown to negatively effect reaction time and reduce readiness to train / wellbeing scores.</p> <p></p>	<p> There is substantial evidence suggesting increasing risk of periodontal disease and 'snuffers lesions'.</p> <p> There is evidence of increased risk of specific cancer types (mainly pancreatic), detrimental to cardiac health and increased risk of T2 diabetes.</p> <p> 2 x MORE LIKELY OF PANCREATIC CANCER (Cancer Research UK)</p> <p> Snus has been positively correlated with increased risk of injury within army conscripts.</p>
<p>Considering all of the above, we recommend that snus use in the elite sport environment is actively discouraged and athletes are educated fully on the risks to health, fitness and performance.</p>		
<p>However snus has been suggested by some researchers to be a better alternative to smoking.</p> <p></p>		

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