Doping prevention through anti-doping education and practical strength training: The Hercules program

ARTICLE *in* PERFORMANCE ENHANCEMENT AND HEALTH · MARCH 2016

DOI: 10.1016/j.peh.2016.01.001

8 AUTHORS, INCLUDING:

Dominic Sagoe

University of Bergen

18 PUBLICATIONS **81** CITATIONS

SEE PROFILE

Geir Holden

Norwegian School of Sport Sciences (NIH)

5 PUBLICATIONS **62** CITATIONS

SEE PROFILE

Gøran Paulsen

Norwegian School of Sport Sciences (NIH)

40 PUBLICATIONS **882** CITATIONS

SEE PROFILE

Fredrik Lauritzen

Anti-doping Norway

14 PUBLICATIONS **263** CITATIONS

SEE PROFILE

Performance Enhancement & Health xxx (2016) xxx–xxx

Contents lists available at ScienceDirect

Performance Enhancement & Health

journal homepage: www.elsevier.com/locate/peh

Doping prevention through anti-doping education and practical strength training: The Hercules program

Dominic Sagoe[a,*,1], Geir Holden[b,1], Eirin Nygaard Karlsholm Rise[c], Therese Torgersen[c], Gøran Paulsen[d], Tron Krosshaug[e], Fredrik Lauritzen[c], Ståle Pallesen[a]

[a] Department of Psychosocial Science, University of Bergen, Christiesgate 12, 5020 Bergen, Norway
[b] Department of Testing, Investigation and Legal, Anti-Doping Norway, Sognsveien 75F, 0855 Oslo, Norway
[c] Department of Prevention and Public Health, Anti-Doping Norway, Sognsveien 75F, 0855 Oslo, Norway
[d] Department of Physical Performance, Norwegian School of Sport Sciences, Sognsveien 220, 0806 Oslo, Norway
[e] Department of Sports Medicine, Norwegian School of Sport Sciences, Sognsveien 220, 0806 Oslo, Norway

ARTICLE INFO

Article history:
Received 1 December 2015
Received in revised form 25 January 2016
Accepted 25 January 2016
Available online xxx

Keywords:
Anti-doping
Anabolic steroids
Hercules program
Prevention
Strength training

ABSTRACT

There is a paucity of well-controlled anti-doping interventions. We developed and evaluated the efficacy of a doping prevention program for adolescents – the Hercules program. The program is different from most anti-doping interventions in the combination of theoretical lessons with practical strength training and inclusion of three groups of participants. A total of 202 high school students (females = 98) aged 15–21 years (mean = 16.9) were randomised to the three groups: control ($n = 50$), theory only ($n = 88$), and theory with workout ($n = 64$). Participants completed baseline and posttest questionnaires including demographic, doping use, and psychophysical items/measures. Data were analysed using chi-square tests and mixed between-within analysis of variance. From baseline to posttest, the theory with workout group gained a higher knowledge of anabolic–androgenic steroids (AAS) and their harmful effects as well as a higher increase in strength training self-efficacy. The Hercules program seems valuable in providing adolescents knowledge on AAS and their harmful effects as well as positive strength training skills. The program elucidates the benefits of combining anti-doping education with practical strength training in doping prevention.

1. Introduction

Although users of doping substances experience some positive effects (Evans, 2004), doping use has been linked to negative consequences such as increased aggression and criminality, premature death and suicide, increased transfusion of blood-borne viruses, cardiovascular pathology, liver disease, dependence and polypharmacy, hirsutism and menstrual disorders in females, as well as gynecomastia and sperm motility in males (Darke, Torok, & Duflou, 2014; Gårevik, Rane, Björkhem-Bergman, & Ekström, 2014; Hope et al., 2015; Klötz, Garle, Granath, & Thiblin, 2006; Pope et al., 2013; Robles-Diaz et al., 2015; Sagoe et al., 2015a). Doping use has also been found to negatively impact societal perception of a user's personality or social image (Sagoe, Huang, Molde, Andreassen, & Pallesen, 2015). Indeed, doping users have been found to experience stigmatisation from health providers (Yu, Hildebrandt, & Lanzieri, 2015).

All major international sports bodies have banned the use of doping substances by professional athletes, and these substances such as anabolic-androgenic steroids(s) (AAS) are illegal or controlled in most countries (World Anti-Doping Agency, 2015). Non-medical use of AAS is considered an issue of public health concern with an overall global lifetime prevalence of 3.3% and a lifetime prevalence of 2.3% for high school students (Sagoe, Molde, Andreassen, Torsheim, & Pallesen, 2014). It is estimated that about 30% of AAS users initiate use before age 20 (Pope et al., 2014). Accordingly, concern has been expressed regarding the use of AAS among adolescents and high school students as, apart from the debilitating effects delineated above, adolescent AAS users may experience stunted growth together with possible irreversible cognitive, emotional, and neurological impairment (Cunningham, Lumia, & McGinnis, 2013; Hildebrandt, Langenbucher, Flores, Harty, & Berlin, 2014; Kicman & Gower, 2003).

* Corresponding author.
E-mail address: dominic.sagoe@uib.no (D. Sagoe).
[1] These authors contributed equally to this work.

http://dx.doi.org/10.1016/j.peh.2016.01.001
2211-2669/

The efficacy of some anti-doping interventions, particularly targeting adolescents and high school students, has been evaluated (Elliot et al., 2004, 2008; Goldberg, Bosworth, Bents, & Trevisan, 1990; Goldberg, Bents, Bosworth, Trevisan, & Elliot, 1991; Goldberg et al., 1996a, 1996b, 2007; Nilsson, Allebeck, Marklund, Baigi, & Fridlund, 2004; Ntoumanis, Ng, Barkoukis, & Backhouse, 2014). One of the most comprehensive anti-doping interventions is the Athletes Training and Learning to Avoid Steroids (ATLAS) program (Goldberg et al., 1996b). The program comprised seven classroom sessions as well as seven strength training sessions. The classroom segment of the program consisted of discussions and information about nutrition, exercise alternatives to AAS, information about the effects of AAS, and role-playing sessions on how to resist pressure to use AAS. It was found that the intervention group increased their belief in their own athletic abilities, had more knowledge about AAS and muscle resistance training, better nutrition, did more exercise and had a lowered intention to use AAS compared to a control group.

The preventive benefits of the ATLAS program have been confirmed (Goldberg et al., 2000) although most of these benefits were not corroborated in another investigation (Fritz et al., 2005). In addition, many interventions focusing on negative health risks or fear appeals have been criticised for exaggerating the dangers associated with doping use and not reflecting the experiences of most doping users who appear healthy (Petróczi, Dodge, Backhouse, & Adesanwo, 2014). A more balanced and level-headed information strategy has therefore been recommended (Backhouse et al., 2014; Berning, Adams, & Stamford, 2004; Hoffman & Ratamess, 2006; Petróczi et al., 2014) as studies of campaigns aimed at preventing substance use in general appear to show that many of these fail to achieve their goal (Foxcroft, Ireland, Lister-Sharp, Lowe, & Breen, 2003).

There is a dearth of published well-controlled studies investigating anti-doping interventions (Backhouse et al., 2014). Accordingly, the European Union's Experts in Doping Prevention in Recreational Sports recently recommended national preventive interventions on doping targeting adolescents and young adults (Backhouse et al., 2014). Consistent with this recommendation, we examined the effects of a primary prevention program, the Hercules program, on recreational doping use in high school students. The program is named after Hercules, the Greek hero noted for his extraordinary natural strength and endurance. Like the ATLAS program, the Hercules program is based on social learning theory which suggests that norms related to drug use are learned through observation of models in an individual's environment (Bandura, 1977). Additionally, the program is founded on the health belief model which indicates that decisions concerning drug use are based on the perceived susceptibility to and severity of the effects of the drug (Janz & Becker, 1984). The program is also anchored in the theory of planned behaviour (Ajzen, 1985) which proposes that behavioural intention (e.g. concerning AAS use) is determined by attitudes, subjective norms and perceived control related to abstinence from AAS use.

The ATLAS program includes and compares two groups: control and theory with workout. This design advances a partitioning problem, raising difficulties in the identification of the unique effect of the theoretical education component in the intervention. In building on the ATLAS program, the Hercules program combines practical strength training and theoretical anti-doping lectures. However, to our knowledge, the present Hercules program is the first anti-doping intervention to include and compare three groups of participants: control, theory only, and theory with workout. Based on the literature reviewed above, we hypothesised that compared to the control, and theory only groups, the theory with workout group will from baseline to posttest have significantly: (a) higher knowledge of AAS and their negative effects, (b) lower prevalence of intent and actual use of AAS, (c) healthier nutrition behaviour, (d) higher strength training self-efficacy, (e) better skills to resist pressure to use drugs, (f) higher muscle appearance satisfaction, and (g) higher negative attitude towards the use of doping substances.

2. Method

2.1. Participants

From three schools located in Vestfold County, Norway, 12 classes and 324 high school students were invited to participate in the study. At baseline, 257 students from 11 classes enrolled in the study (response rate = 79.3%) with 202 of these participating in the posttest (dropout rate = 21.4%).

Participants were randomly assigned to one of three groups: control, theory only, and theory with strength training. The control group comprised 50 students (females = 29). Their ages ranged from 15 to 20 years (mean = 16.6, *SD* = .79) at baseline. The theory only participants were 88 students (females = 36) aged between 16 and 21 years (mean = 16.9, *SD* = .69). The theory with workout group consisted of 64 students (females = 33). At baseline, their ages ranged between 16 and 18 years (mean = 16.9, *SD* = .39).

The overall lifetime and current prevalence of AAS use was 1.5% (95% CI = 0.18 – 3.18) at baseline (males = 1.0%, females = 2.0%). Current prevalence was 0.0% at posttest. Moreover, 20.8% (baseline) and 20.3% (posttest) of participants reported personally knowing at least one former or current AAS user.

The theory with workout group consisted of a higher proportion of organised sports participants followed by the theory only group, and the control group [baseline: χ^2 (2) = 11.2, $p < .01$, Cramer's $V = .236$; posttest: χ^2 (2) = 9.2, $p < .05$, Cramer's $V = .214$] (see Table 1). Other baseline and posttest characteristics of the sample are presented in Table 1 and were not different across groups.

2.2. Measures

All participants completed an electronic questionnaire at baseline and after the intervention. The questionnaire consisted of the following elements.

2.2.1. Demography

This comprised questions about age, gender, living situation, number of siblings, and sports participation.

2.2.2. Physical strength

Self-rated physical strength was assessed with the question: "How would you describe your physical strength?" Response options were "far below average", "slightly below average", "average", "slightly above average", and "far above average" – 'compared with my peers'.

2.2.3. AAS use

Use of AAS was assessed with the question: "Have you ever used anabolic–androgenic steroids?" Response options were 'yes and currently', 'yes, but no more', and 'no'. Participants also indicated whether they personally knew a current or former AAS user (yes/no).

2.2.4. AAS knowledge

Due to the lack of established well-functioning scales assessing knowledge of AAS and their negative effects, we developed a multiple choice knowledge test in collaboration with Prof. Harrison G. Pope Jr., a leading expert in the field. The test comprises 21 items, each with four response alternatives whereof one of these represents a correct answer. An example item is: "What are anabolic

Please cite this article in press as: Sagoe, D., et al. Doping prevention through anti-doping education and practical strength training: The Hercules program. *Performance Enhancement & Health* (2016), http://dx.doi.org/10.1016/j.peh.2016.01.001

Table 1
Characteristics of the study sample at baseline and posttest.

Variable	Control ($n = 50$)		Theory only ($n = 88$)		Theory and workout ($n = 64$)		Overall ($N = 202$)	
	Baseline *n*	Posttest *n*	Baseline *n*	Posttest *n*	Baseline *n*	Posttest *n*	Baseline *n* (%)	Posttest *n* (%)
Living situation								
Both parents	32	32	62	60	45	45	139 (68.8)	137 (67.8)
Single parent	17	17	25	26	16	17	58 (28.7)	60 (29.7)
Alone	0	0	1	2	1	1	2 (1.0)	3 (1.5)
Friends/household/dormitory	1	1	0	0	2	1	3 (1.5)	2 (1.0)
Anabolic steroids								
Currently	1	0	2	0	0	0	3 (1.5)	0
No	49	50	86	88	64	64	199 (98.5)	202 (100)
Know anabolic steroid user								
No	41	39	66	69	53	53	160 (79.2)	161 (79.7)
Yes	9	11	22	19	11	11	42 (20.8)	41 (20.3)
Alcohol								
No	21	18	44	43	24	24	89 (44.1)	85 (42.1)
Yes	29	32	44	45	40	40	113 (55.9)	117 (57.9)
Cigarette								
No	34	34	69	75	57	59	160 (79.2)	168 (83.2)
Yes	4	2	3	4	1	0	8 (4.0)	6 (3.0)
Occasionally	12	14	16	9	6	5	34 (16.8)	28 (13.9)
Snus								
No	40	38	71	75	53	55	164 (81.2)	168 (83.2)
Yes	10	12	17	13	11	9	38 (18.8)	34 (16.8)
Sports/sports club[†,§]								
No	27	28	44	49	17	21	88 (43.6)	98 (48.5)
Yes	23	22	44	39	47	43	114 (56.4)	104 (51.5)
Physical strength								
Far below average	2	2	1	2	1	1	4 (2.0)	5 (2.5)
Slightly below average	4	6	13	17	10	6	27 (13.4)	29 (14.4)
Average	28	21	36	32	24	24	88 (43.6)	77 (38.1)
Slightly above average	14	17	30	30	24	28	68 (33.7)	75 (37.1)
Far above average	2	4	8	7	5	5	15 (7.4)	16 (7.9)

[†] Baseline comparison: %(control < theory only < theory and workout) $p < .01$.
[§] Posttest comparison: %(control < theory only < theory and workout) $p < .05$.

steroids?" Response options are "chemical derivatives of creatine", "chemical derivatives of hemoglobin", "chemical derivatives of testosterone", and "chemical derivatives of muscle enzymes" with the third option representing the correct answer. A correct answer is scored '1' and a wrong answer scored '0'. An index score was computed by summing scores on all items. Total scores range from 0 to 21 with high scores indicating higher knowledge.

2.2.5. AAS use intent

AAS use contemplation was assessed using the Intent to use AAS Scale (IAS; MacKinnon et al., 2001). The IAS consists of 5 items. An example item is "I would be willing to use steroids to know how it feels". Each item is rated on a 5-point Likert Scale ranging from strongly disagree (1) to strongly agree (5). Total scores range between 1 and 25 with high scores denoting higher intent to use AAS. Cronbach's alphas were .95 and .96 at baseline and posttest respectively.

2.2.6. Alcohol and tobacco use

Participants indicated whether they drink alcohol (yes/no), smoke cigarettes (yes/no/occasionally), use snus or smokeless tobacco (yes/no).

2.2.7. Nutrition behaviour

Participants' nutrition behaviour was assessed using the Nutrition Behaviors Scale (NBS; MacKinnon et al., 2001). The NBS has a total of 7 items, each with a response format ranging from strongly disagree (1) to strongly agree (5). An example item is "I am aware of the calorie content of the food I eat". Total scores range from 7 to 35 with high scores indicating adherence to healthier nutrition behaviour. Cronbach's alpha was .85 at baseline and .88 at posttest.

2.2.8. Strength training self-efficacy

Efficiency at strength training was assessed with the Strength Training Self-Efficacy Scale (STSES; MacKinnon et al., 2001): The STSES has a total of 6 items. An example item is "I know how to train with weights to get more power". Each item is scored along a 5-point Likert scale ranging from strongly disagree (1) to strongly agree (5) with high scores signifying more efficiency at strength training. The STSES yielded a Cronbach's alpha of .85 at baseline and .87 at posttest.

2.2.9. Attitude towards drug offers

Participants' ability to resist pressure from different sources to use AAS and other drugs was assessed using the Ability to Say No to Drugs Scale (MacKinnon et al., 2001). This scale contains four items reflecting the ability to resist. Each item is scored on a Likert scale ranging from strongly disagree (1) to strongly agree (5) with high scores denoting higher ability to resist the temptation to use drugs. An example of an item is "I would be comfortable turning down a fried who offered me anabolic steroids". The total score ranges from 4 to 20. The scale yielded good psychometric properties (Cronbach's alphas: baseline = .90, posttest = .92).

2.2.10. Muscle appearance satisfaction

A short version of the Muscle Appearance Satisfaction Scale (Ryan & Morrison, 2010) was used in the assessment of participants' satisfaction with the appearance of their muscles and symptoms of muscle dysmorphia. This scale contains 6 items. An example item is "I often find it difficult to resist checking the size of my muscles". Each item is answered along a five point Likert scale [strongly disagree (1) to strongly agree (5)], resulting in a total composite score ranging from 6 to 30. High scores indicate higher satisfaction with

Please cite this article in press as: Sagoe, D., et al. Doping prevention through anti-doping education and practical strength training: The Hercules program. *Performance Enhancement & Health* (2016), http://dx.doi.org/10.1016/j.peh.2016.01.001

Table 2
Description of the Hercules program.

Program aspect	Content	
Theoretical session 1	Basic principles of exercise and strength training	
Theoretical session 2	Biomechanics of strength training	
Theoretical session 3	Nutrition and dietary supplementation	
Theoretical session 4	Sports ethics, anti-doping, anabolic steroids and their adverse health effects, dealing with peer-pressure	
Strength training sessions	Once per week	
	Squat, deadlift, bench press, standing shoulder press, lat pulldown, seated row, standing barbell twist	
	Week 1–3	3 × 12 repetition maximum
	Week 4	1 × 12 repetition maximum
	Week 5–8	3 × 8 repetition maximum
	Week 9	1 × 8 repetition maximum
	Week 10–12	4 × 4–6 repetition maximum

one's muscle appearance. Cronbach's alphas were .83 at baseline and .86 at posttest.

2.2.11. Attitude towards doping

The Performance Enhancement Attitude Scale (PEAS; Petróczi & Aidman, 2009) was used in assessing participants' attitudes towards doping and the use of other ergogenic aids. The PEAS comprises 17 items. An example item is: "Doping is necessary to be competitive". Each item is rated on a 6-point Likert scale anchored from strongly disagree (1) to strongly agree (6) with high scores signifying a more positive attitude towards ergogenic enhancement or doping. The PEAS total scores range from 17 to 102. At baseline, the PEAS yielded a Cronbach's alpha of .89, and .91 at posttest.

2.3. Procedure and description of the program

Three classes were randomly allocated to a control condition, while four classes were randomised to receive a theoretical/classroom education. Finally, four classes were randomised to receive, in addition to the theoretical/classroom education supervised strength training exercises.

The theoretical or classroom education consisted of four 90-min sessions. For the first session, participants were introduced to the basic fundamental principles of exercise and strength training. The second session dealt with the biomechanical principles of strength training. For the third session, participants were provided instruction on adequate and appropriate nutrition behaviour and dietary supplementation. The final theoretical session covered the ethics of sports, anti-doping, AAS and their debilitating psychophysical effects, and peer-pressure resistance.

The practical aspect comprised twelve sessions or weeks of guidance and supervised strength training exercises. Participants were acquainted with the following exercises: squat, deadlift, bench press, standing shoulder press, lat pulldown, seated row, and standing barbell twist. The program was implemented by staff of Anti-Doping Norway in collaboration with relevant academic staff of the schools. Table 2 presents a description of aspects of the program.

2.4. Statistical analysis

The analysis was conducted using a modified intention-to-treat (mITT) approach. Accordingly, although we strictly adhered to randomisation, dropouts were excluded from the final analysis. Our preference for mITT was to overcome criticisms regarding data imputation associated with the intention-to-treat (ITT) approach (Altman, 2009; Baron, Boutron, Giraudeau, & Ravaud, 2005). Descriptive statistics were used to ascertain characteristics of the sample. Chi-square analysis was used to compare differences in sample characteristics at baseline and posttest. The effects of the intervention were analysed using mixed between-within analysis of variance (ANOVA). There was one repeated measurement factor with two levels: time (baseline versus posttest), and one between groups factor, condition with three factors (control, theory only, and theory with workout). Three separate Tukey's post hoc analyses (control versus theory with workout; control versus theory only; theory only versus theory with workout) were conducted to examine the differences between means of significant group–time interactions. Setting alpha to .05, power to .80, Cohen's d to 0.20 and the correlation between the two repeated measurements to 0.70, a minimum of 50 participants were required in each condition in order to detect significant interaction effects.

3. Results

3.1. Main group effect

Results of the mixed between-within ANOVA revealed three significant main group effects: nutrition behaviours [$F(2, 199) = 3.68$, $p < .028$], strength training self-efficacy [$F(2, 199) = 4.11$, $p < 0019$], and muscle appearance satisfaction [$F(2, 199) = 5.59$, $p < .005$]. Specifically, the control group had an overall higher score on nutrition behaviours compared to the theory only group. Additionally, the theory with workout group recorded a higher overall score on strength training self-efficacy and muscle appearance satisfaction compared to the theory only group. See Table 3.

3.2. Main time effect

A significant effect of time was detected for AAS knowledge [$F(1, 199) = 10.93$, $p < .002$]. This reflected an overall increase in knowledge over time from baseline to posttest. See Table 3.

3.3. Interaction effect (Group × Time)

There were also significant interaction effects of group and time on AAS knowledge [$F(2, 199) = 3.33$, $p < .039$] and strength training self-efficacy [$F(2, 199) = 9.89$, $p < .001$].

Consistent with our prediction, the theory with workout group gained deeper knowledge of AAS and their harmful effects from baseline to posttest compared to the control group ($p < .05$). Furthermore, as predicted, the theory with workout group had a higher increase in strength training self-efficacy from baseline to posttest compared to the control group, and the theory only group ($p < .001$). See Table 3.

4. Discussion

We developed and evaluated the efficacy of the Hercules program, an adolescent-targeted doping prevention intervention that combines theoretical lessons with practical strength training and uniquely includes and compares three groups: control, theory only, and theory with strength training. Consistent with our prediction, it was evident in the present study that in comparison with the control group, the theory with workout group acquired better knowledge of AAS and their negative consequences from baseline to posttest consistent with evidence from a previous intervention (Fritz et al., 2005).

Please cite this article in press as: Sagoe, D., et al. Doping prevention through anti-doping education and practical strength training: The Hercules program. *Performance Enhancement & Health* (2016), http://dx.doi.org/10.1016/j.peh.2016.01.001

Table 3
The effects of groups/conditions on study variables.

Variable	Range	Control		Theory only		Theory and workout		Main effect Group	Main effect Time	Interaction Group × Time
		Baseline Mean SD	Posttest Mean SD	Baseline Mean SD	Posttest Mean SD	Baseline Mean SD	Posttest Mean SD	F[†]	F[§]	F[†]
Anabolic steroid knowledge	0–21	7.76	7.68	7.91	8.73	7.81	9.09	1.93	10.93[**]	3.33[*,b]
		2.47	2.60	2.56	2.51	2.36	2.61			
Anabolic steroid use intent	1–25	6.14	5.52	6.07	6.81	5.77	5.61	2.37	0	2.84
		2.93	1.33	3.35	3.81	2.00	1.67			
Nutrition behaviours	7–35	20.14	20.58	17.41	18.23	19.00	18.36	3.68[*,a]	.29	1.47
		5.66	6.48	6.11	5.32	5.96	6.08			
Strength training self-efficacy	6–30	22.72	22.22	20.82	20.38	21.08	23.53	4.11[*,c]	2.58	9.89[***,b,c]
		4.38	5.12	5.45	5.97	3.97	3.20			
Ability to turn down drug offers	4–20	17.16	18.02	18.14	17.86	18.56	18.36	1.16	.16	.16
		4.26	3.57	3.62	4.03	3.51	3.71			
Muscle appearance satisfaction	1–30	13.60	13.40	12.24	12.83	15.16	15.23	5.59[**,c]	.27	.65
		4.59	4.62	5.54	5.83	4.97	5.35			
Performance enhancement attitude	17–102	34.00	32.10	32.01	33.02	36.70	34.22	.255	1.30	1.43
		10.70	11.04	12.06	13.99	14.78	14.15			

[*] $p < .05$.
[**] $p < .01$.
[***] $p < .001$.
[†] Degrees of freedom = 2, 199.
[§] Degrees of freedom = 1, 199.
[a] Significant difference between control and theory only.
[b] Significant difference between control and theory with workout.
[c] Significant difference between theory only and theory with workout.

Knowledge of AAS and their side effects has been identified as a protective factor in adolescents' initiation of AAS use (Ntoumanis et al., 2014). First, the paucity of knowledge on AAS and their harmful effects may render adolescents more prone to initiating use due to false information about AAS from individuals in their social network such as peers and trainers or coaches (Petróczi et al., 2014). Second, inferring from the health belief model (Rosenstock, 1966, 1974), adolescents are more likely to avoid initiating AAS use if they perceive the potential negative consequences of use more negatively compared to the potential benefits (Goldberg et al., 2003; Ntoumanis et al., 2014). It is inferable from the above that the knowledge of AAS and their negative or injurious effects acquired through the Hercules program may be of value in doping prevention. On the other hand, from a harm reduction or secondary prevention perspective, it is foreseeable that the knowledge acquired by current users may help them minimise AAS-associated risks or harms.

Moreover, the strength training culture or regimen provided as a complement to the theoretical instruction proved beneficial as the participating group exhibited, consistent with our prediction, a significantly higher increase in strength training self-efficacy from baseline to posttest compared to non-participating groups. Concern has been expressed regarding adolescents' acquisition of AAS-related knowledge per se. It has been indicated that such knowledge may lead to increased curiosity and temptation to experiment with AAS (Goldberg et al., 1991; Yesalis & Bahrke, 2000). Some individuals may reject the acquired knowledge and experiment with AAS in approval of the construction of AAS use as a strength training subculture or norm (Monaghan, 2002; Sagoe, Andreassen, & Pallesen, 2014). Thus, Monaghan (2002) indicates that health promotion interventions are more likely to be efficient when linked to the values influencing targets' personalities and way of life. It has also been underscored that appropriate training, when presented as an alternative to AAS use, is an effective means of preventing adolescents' and high school students' initiation of AAS use (Elliot & Goldberg, 1996). Accordingly, the increased strength training self-efficacy imparted in the Hercules program may prove useful in the prevention of doping.

It is recommended that preventive interventions deepen adolescents' ability to identify and reject false or deficient information meant to convince them to start AAS use Petróczi et al. (2014). Hence, as part of the appropriate nutritional practice, anti-doping and substance use education, participants were imparted refusal or temptation coping skills although no statistically significant differences were observed between groups from baseline to posttest. Although the theory with workout group gained a higher knowledge of AAS and their negative effects, their responses on questions regarding future intent to use AAS were not significant compared to the control group. This may be attributed to the fact that intent to initiate AAS use was low in the sample perhaps due to their young age (Pope et al., 2014).

The combination of theoretical lessons and practical strength training is a notable strength of the Hercules program. In addition, as far as we are aware, the Hercules program is the pioneering inclusion and comparison of three groups (control, theory only, and theory with practical strength training) in an anti-doping intervention. The use of several well-validated instruments is another strength of the present study. Some limitations of the current study ought to be noted. First, the theory with workout group's composition of a comparatively higher proportion of organised sports participants at baseline is a possible explanation for their gains in AAS knowledge and strength training self-efficacy. Also, data was collected using self-reports which may have limited validity. For instance, it is plausible that the prevalence of AAS use estimated in the present study may be exaggerated by false positive responses. It must be noted however that the assessment of AAS use in the present study, in our view, meets best practice guidelines as questions were complemented and nuanced with the AAS knowledge test as a means of reducing false positive responses.

Additionally, among the theory only group and generally, there was a reduction in the prevalence of perceived use of AAS by others. This reduction may be attributed to the false consensus effect in terms of the false attribution of AAS use to others at baseline. With the knowledge acquired through the theoretical education, some participants overcame the projection bias and corrected such false attribution at posttest. Finally, further investigation showed that the theory with workout dropouts comprised of a significantly higher proportion of organised sports participants and smokers compared to the control, and theory only dropouts. It is plausible that their retention could have affected our findings. Future studies with larger samples and other age as well as occupational groups are recommended.

5. Conclusions

The paucity of empirical well-controlled anti-doping interventions demands the development and testing of new interventions (Backhouse et al., 2014). The present evaluation of the Hercules program reveals its value in educating adolescents about AAS and their enervating effects as well as providing them adequate strength training skills. Overall, the program provides insights into the benefits of combining anti-doping education with practical strength training in the prevention of doping among youth. The program represents a primary anti-doping intervention that can be implemented on a large scale in high schools.

Funding

The Norwegian Directorate of Health through a grant to Anti-Doping Norway funded the Hercules program.

References

Ajzen, I. (1985). From intentions to actions: A theory of planned behavior. In J. Kuhi, & J. Beckmann (Eds.), *Action control: From cognition to behavior* (pp. 11–39). Heidelberg: Springer.

Altman, D. G. (2009). Missing outcomes in randomized trials: Addressing the dilemma. *Open Medicine, 3*, e51–e53.

Backhouse, S. H., Collins, C., Defoort, Y., McNamee, M., Parkinson, A., & Sauer, M. (2014). *Study on doping prevention: A map of legal regulatory and prevention practice provisions in EU 28*. Luxembourg: Publications Office of the European Union.

Bandura, A. (1977). *Social learning theory*. Englewood Cliffs, NJ: Prentice Hall.

Baron, G., Boutron, I., Giraudeau, B., & Ravaud, P. (2005). Violation of the intent-to-treat principle and rate of missing data in superiority trials assessing structural outcomes in rheumatic diseases. *Arthritis & Rheumatism, 52*, 1858–1865.

Berning, J. M., Adams, K. J., & Stamford, B. A. (2004). Anabolic steroid usage in athletics: Facts, fiction, and public relations. *Journal of Strength & Conditioning Research, 18*, 908–917.

Cunningham, R. L., Lumia, A. R., & McGinnis, M. Y. (2013). Androgenic anabolic steroid exposure during adolescence: Ramifications for brain development and behavior. *Hormones and Behavior, 64*, 350–356.

Darke, S., Torok, M., & Duflou, J. (2014). Sudden or unnatural deaths involving anabolic–androgenic steroids. *Journal of Forensic Sciences, 59*, 1025–1028.

Elliot, D., & Goldberg, L. (1996). Intervention and prevention of steroid use in adolescents. *American Journal of Sports Medicine, 24*, s46–s47.

Elliot, D. L., Goldberg, L., Moe, E. L., DeFrancesco, C. A., Durham, M. B., McGinnis, W., et al. (2008). Long-term outcomes of the ATHENA (Athletes Targeting Healthy Exercise and Nutrition Alternatives) program for female high school athletes. *Journal of Alcohol and Drug Education, 52*, 73–92.

Elliot, D. L., Goldberg, L., Moe, E. L., DeFrancesco, C. A., Durham, M. B., & Hix-Small, H. (2004). Preventing substance use and disordered eating: Initial outcomes of the ATHENA (Athletes Targeting Healthy Exercise and Nutrition Alternatives) program. *Archives of Pediatrics & Adolescent Medicine, 158*, 1043–1049.

Evans, N. A. (2004). Current concepts in anabolic–androgenic steroids. *American Journal of Sports Medicine, 32*, 534–542.

Foxcroft, D. R., Ireland, D., Lister-Sharp, D. J., Lowe, G., & Breen, R. (2003). Longer-term primary prevention for alcohol misuse in young people: A systematic review. *Addiction, 98*, 397–411.

Please cite this article in press as: Sagoe, D., et al. Doping prevention through anti-doping education and practical strength training: The Hercules program. *Performance Enhancement & Health* (2016), http://dx.doi.org/10.1016/j.peh.2016.01.001

Fritz, M. S., MacKinnon, D. P., Williams, J., Goldberg, L., Moe, E. L., & Elliot, D. L. (2005). Analysis of baseline by treatment interactions in a drug prevention and health promotion program for high school male athletes. *Addictive Behaviors, 30*, 1001–1005.

Gårevik, N., Rane, A., Björkhem-Bergman, L., & Ekström, L. (2014). Effects of different doses of testosterone on gonadotropins, 25-hydroxyvitamin D3, and blood lipids in healthy men. *Substance Abuse and Rehabilitation, 5*, 121–127.

Goldberg, L., Bents, R., Bosworth, E., Trevisan, L., & Elliot, D. L. (1991). Anabolic steroid education and adolescents: Do scare tactics work? *Pediatrics, 87*, 283–286.

Goldberg, L., Bosworth, E. E., Bents, R. T., & Trevisan, L. (1990). Effect of an anabolic steroid education program on knowledge and attitudes of high school football players. *Journal of Adolescent Health Care, 11*, 210–214.

Goldberg, L., Elliot, D., Clarke, G. N., MacKinnon, D. P., Moe, E., Zoref, L., et al. (1996). Effects of a multidimensional anabolic steroid prevention intervention: The Adolescents Training and Learning to Avoid Steroids (ATLAS) Program. *JAMA, 276*, 1555–1562.

Goldberg, L., Elliot, D., Clarke, G. N., MacKinnon, D. P., Zoref, L., Moe, E., et al. (1996). The Adolescents Training and Learning to Avoid Steroids (ATLAS) prevention program: Background and results of a model intervention. *Archives of Pediatrics & Adolescent Medicine, 150*, 713–721.

Goldberg, L., Elliot, D. L., MacKinnon, D. P., Moe, E., Kuehl, K. S., Nohre, L., & Lockwood, C. M. (2003). Drug testing athletes to prevent substance abuse: background and pilot study results of the SATURN (Student Athlete Testing Using Random Notification) study. *Journal of Adolescent Health, 32*, 16–25.

Goldberg, L., Elliot, D., MacKinnon, D. P., Moe, E., Kuehl, K. S., Yoon, M., et al. (2007). Outcomes of a prospective trial of student-athlete drug testing: The student athlete testing using random notification (SATURN) study. *Journal of Adolescent Health Care, 41*, 421–429.

Goldberg, L., MacKinnon, D. P., Elliot, D., Moe, E. L., Clarke, G., & Cheong, J. (2000). The adolescents training and learning to avoid steroids program: Preventing drug use and promoting health behaviors. *Archives of Pediatrics & Adolescent Medicine, 154*, 332–338.

Hildebrandt, T., Langenbucher, J. W., Flores, A., Harty, S., & Berlin, H. (2014). The influence of age of onset and acute anabolic steroid exposure on cognitive performance, impulsivity, and aggression in men. *Psychology of Addictive Behaviors, 28*, 1096–1104.

Hope, V. D., Harris, R., McVeigh, J., Cullen, K. J., Smith, J., Parry, J. V., et al. (2015). Risk of HIV and hepatitis B and C over time among men who inject image and performance enhancing drugs in England and Wales: Results from cross-sectional prevalence surveys 1992-2013. *Journal of Acquired Immune Deficiency Syndromes*, http://dx.doi.org/10.1097/QAI.0000000000000835

Hoffman, J. R., & Ratamess, N. A. (2006). Medical issues associated with anabolic steroid use: Are they exaggerated? *Journal of Sports Science and Medicine, 5*, 182–193.

Janz, N. K., & Becker, M. H. (1984). The health belief model: A decade later. *Health Education & Behavior, 11*, 1–47.

Kicman, A. T., & Gower, D. B. (2003). Anabolic steroids in sport: Biochemical, clinical and analytical perspectives. *Annals of Clinical Biochemistry, 40*, 321–356.

Klötz, F., Garle, M., Granath, F., & Thiblin, I. (2006). Criminality among individuals testing positive for the presence of anabolic androgenic steroids. *Archives of General Psychiatry, 63*, 1274–1279.

MacKinnon, D. P., Goldberg, L., Clarke, G. N., Elliot, D. L., Cheong, J., Lapin, A., et al. (2001). Mediating mechanisms in a program to reduce intentions to use anabolic steroids and improve exercise self-efficacy and dietary behavior. *Prevention Science, 2*, 15–28.

Monaghan, L. F. (2002). Vocabularies of motive for illicit steroid use among bodybuilders. *Social Science & Medicine, 55*, 695–708.

Nilsson, S., Allebeck, P., Marklund, B., Baigi, A., & Fridlund, B. (2004). Evaluation of a health promotion programme to prevent the misuse of androgenic anabolic steroids among Swedish adolescents. *Health Promotion International, 19*, 61–67.

Ntoumanis, N., Ng, J. Y., Barkoukis, V., & Backhouse, S. (2014). Personal and psychosocial predictors of doping use in physical activity settings: a meta-analysis. *Sports Medicine, 44*, 1603–1624.

Petróczi, A., & Aidman, E. (2009). Measuring explicit attitude toward doping: Review of the psychometric properties of the Performance Enhancement Attitude Scale. *Psychology of Sport and Exercise, 10*, 390–396.

Petróczi, A., Dodge, T., Backhouse, S. H., & Adesanwo, C. (2014). Review of the literature on negative health risks based interventions to guide anabolic steroid misuse prevention. *Performance Enhancement & Health, 3*, 31–44.

Pope, H. G., Jr., Kanayama, G., Athey, A., Ryan, E., Hudson, J. I., & Baggish, A. (2014). The lifetime prevalence of anabolic–androgenic steroid use and dependence in Americans: Current best estimates. *American Journal on Addictions, 23*, 371–377.

Pope, H. G., Jr., Wood, R. I., Rogol, A., Nyberg, F., Bowers, L., & Bhasin, S. (2013). Adverse health consequences of performance-enhancing drugs: An Endocrine Society scientific statement. *Endocrine Reviews, 35*, 341–375.

Robles-Diaz, M., Gonzalez-Jimenez, A., Medina-Caliz, I., Stephens, C., García-Cortes, M., García-Muñoz, B., et al. (2015). Distinct phenotype of hepatotoxicity associated with illicit use of anabolic androgenic steroids. *Alimentary Pharmacology & Therapeutics, 41*, 116–125.

Rosenstock, I. M. (1966). Why people use health services? *The Milbank Memorial Fund Quarterly, 44*, 94–124.

Rosenstock, I. M. (1974). Historical origins of the health belief model. *Health Education and Behavior, 2*, 328–335.

Ryan, T. A., & Morrison, T. G. (2010). Psychometric properties of the muscle appearance satisfaction scale among Irish and British men. *Body Image, 7*, 246–250.

Sagoe, D., Andreassen, C. S., & Pallesen, S. (2014). The aetiology and trajectory of anabolic–androgenic steroid use initiation: A systematic review and synthesis of qualitative research. *Substance Abuse Treatment, Prevention, and Policy, 9*, 27. http://dx.doi.org/10.1186/1747-597X-9-27

Sagoe, D., Molde, H., Andreassen, C. S., Torsheim, T., & Pallesen, S. (2014). The global epidemiology of anabolic–androgenic steroid use: A meta-analysis and meta-regression analysis. *Annals of Epidemiology, 24*, 383–398.

Sagoe, D., McVeigh, J., Bjørnebekk, A., Essilfie, M. S., Andreassen, C. S., & Pallesen, S. (2015). Polypharmacy among anabolic–androgenic steroid users: A descriptive metasynthesis. *Substance Abuse Treatment, Prevention, and Policy, 10*, 12. http://dx.doi.org/10.1186/s13011-015-0006-5

Sagoe, D., Huang, K., Molde, H., Andreassen, C. S., & Pallesen, S. (2015). Perceived anabolic–androgenic steroid use is associated with perceived neuroticism. *Journal of Substance Use*, http://dx.doi.org/10.3109/14659891.2015.1009510

World Anti-Doping Agency. (2015). *World Anti-Doping Code 2015*. Montreal: World Anti-Doping Agency.

Yesalis, C. E., & Bahrke, M. S. (2000). Doping among adolescent athletes. *Best Practice & Research Clinical Endocrinology & Metabolism, 14*, 25–35.

Yu, J., Hildebrandt, T., & Lanzieri, N. (2015). Healthcare professionals' stigmatization of men with anabolic androgenic steroid use and eating disorders. *Body Image, 15*, 49–53.

Please cite this article in press as: Sagoe, D., et al. Doping prevention through anti-doping education and practical strength training: The Hercules program. *Performance Enhancement & Health* (2016), http://dx.doi.org/10.1016/j.peh.2016.01.001