Institution: Kingston University		
Unit of Assessment: 3 – Allied Health Professions, Dentistry, Nursing and Pharmacy		
Title of case study: Protecting Sport by Improving the World Anti-Doping Agency's Capability for Assessing Doping Prevalence		
Period when the underpinning research was undertaken: 2009 – 2020		
Details of staff conducting the underpinning research from the submitting unit:		
Names:	**Roles:**	**Periods employed by submitting HEI:**
Andrea Petróczi	Professor	Sept 2001 – present
Declan Naughton	Professor, Associate Dean for Research	Aug 2005 – present
Period when the claimed impact occurred: Aug 2013 – 2020		
Is this case study continued from a case study submitted in 2014? N		

1. Summary of the impact

The global anti-doping community has made considerable effort towards more accurate determination of doping prevalence – for the sake of athletes, spectators, and the integrity of sport. Research conducted at Kingston University by Professor Andrea Petróczi on survey methodologies and compliance has led to:

- the prioritisation of the Prevalence Project by World Anti-Doping Agency (WADA), recognising it as essential in accurate assessment of the cost-effectiveness of anti-doping programmes

- a novel, cost-effective and non-intrusive survey-based tool, already used at multiple major sports events, such as the Commonwealth Games, and now fully adopted by WADA

- a new multi-method framework for qualitatively combining different evidences of doping, which WADA sees as 'a big step forward' towards accurate measurement of doping prevalence

2. Underpinning research

Measuring the prevalence of doping on an international scale is a challenging task. While analytical methods or the Athlete Biological Passport (ABP) profiles are suitable tools at the individual test level, they are both expensive and limited in their determinative power. Self-reporting through surveys is an insightful and inexpensive way to provide information on this unobservable behaviour. Whilst completely honest self-reporting by athletes is unlikely, data quality and reliability can be significantly improved by creating a completely safe survey situation. A credible estimate for doping prevalence in each athlete population can be derived by combining different evidence sources (e.g., doping tests, ABP data and self-reported survey), overcoming the inherent limitations of each independent method.

Supporting her empirical research on identifying predictors and indicators of doping behaviour over the past two decades, Petróczi's work has made foundational contributions to methods for gathering data on doping behaviour. The research by Petróczi and her team in Kingston, which highlighted the questionable validity of self-reports in doping research **[R1]**, caught the attention of the WADA and led to the invitation of Petróczi in 2010 to the Working Group on Doping Prevalence (2011-2012).

Working closely with WADA, Petróczi developed a new survey-based method suitable for epidemiology-scale investigation of sensitive behaviour, called the Single Sample Count (SCC). This is a computationally simple, indirect estimation model, suitable for self-administration **[R2]**. In SCC, the sensitive doping question is embedded among four unrelated questions – leading to

a single "fuzzy" answer. Using external knowns or statistical likelihoods it is possible to estimate how the population respondents answered the sensitive doping question. In the traditional, established Unrelated Question Model (UQM), multiple, randomised questions are asked, meaning only the respondent knows whether the sensitive doping question has been answered. As part of the 2011-2012 Doping Prevalence Project, the SSC model was administered and tested alongside the UQM at two major world-class sport events - the Athletic World Championship in Daegu (n=1,203) and the Pan-Arab Games in Doha (n=1,919). Results from the UQM returned an extraordinarily high rate of admitted doping use, 43.6% (39.4%-47.9%) and 57.1% (52.4%-61.8%), respectively **[R3]**. The SSC method challenged these estimations with significantly lower figures at 21.2% (9.68%-32.7%) and 10.6% (1.76%-19.4%), respectively, but still above the testing figures of 1-2% for elite athlete doping.

To elucidate this surprising outcome, an independent UK-based study was conducted which replicated and tested the survey scenario used in Daegu, with 513 club-level athletes **[R4]**. The results again showed similarly inflated estimates with the UQM model which was hypothesised to be caused by a self-protective noncompliance strategy: participants deliberately avoiding the doping question or choosing the "anti-doping answer". Petróczi conducted an additional study among those in executive managerial positions (n=124), using the breaking of business ethics principles as a sensitive behaviour by which to understand the motives and mechanisms of noncompliant behaviour. The results supported the hypothesis that it is common for participants to change controllable parameters to avoid sensitive questions, with survey participants not considering this as cheating the survey. Thus, it was showed that whilst safe survey conditions are necessary to protect against exposure and consequences, alone they are not sufficient for admitting transgression and will instead lead to non-compliance with the survey.

There was clear evidence that deliberate and/or careless noncompliance was present, and this influenced prevalence estimation to a non-negligible degree, despite the safe survey situation **[R4]**. To address this problem, Petróczi and her research team in Kingston improved the SSC model and demonstrated its functionality with a sample of students entering university (n=1,441) **[R5]**. This method had a key advantage over traditional models such as UMQ: for the first-time non-compliance was not only detected but also modelled and attributed to clean and doping users (without the additional strain from dual sampling).

In conclusion, these studies:

- challenged the feasibility of any traditional or 'off-the-shelf' models;
- underscored the importance of considering the behavioural aspects in using indirect estimation models alongside the mathematical aspects for improved efficiency;
- articulated the research direction for WADA of implementing a survey-based tool for estimating doping prevalence.

Advocating for multidisciplinary research and evidence synthesis also featured prominently in Petróczi's scholarship **[R1, R2, R6]**. Doping is a complex issue that spreads across many fields. The research showed that only careful combination of different methodologies can overcome limitations that affect each method if used independently or in isolation. This careful combination advances anti-doping benefits, anti-doping research and evidence gathering **[R1, R2]**.

3. References to the research

R1 – **Petróczi, A.**, Uvacsek, M., Nepusz, T., Deshmukh, N., Shah, I., Aidman, E. V., ... & **Naughton, D. P**. (2011). Incongruence in doping related attitudes, beliefs and opinions in the context of discordant behavioural data: in which measure do we trust?. PLoS One, 6(4), e18804. DOI: 10.1371/journal.pone.0018804

- This is a multi-method paper with objective validation for estimated self-reports
- Linked to 2010-2011 WADA grant of GBP18,234.00 (PI)
- Linked to 2008-2010 WADA social science research grant of GBP23,200.00 (PI)

R2 – **Petróczi, A.**, Nepusz, T., Cross, P., Taft, H., Shah, S., Deshmukh, N., Schaffer, J., Shane, M., Adesanwo, C., Barker, J., & **Naughton, D. P.** (2011). New non-randomised model to assess the prevalence of discriminating behaviour: a pilot study on mephedrone. Substance Abuse Treatment, Prevention, and Policy, 6, 20. DOI: 10.1186/1747-597X-6-20

- This is a multi-method paper with objective validation for estimated self-reports.

R3 – Ulrich, R., Pope, H. G., Cléret, L., **Petróczi, A.**, Nepusz, T., Schaffer, J., Kanayama, G., Comstock, R.D., & Simon, P. (2018). Doping in two elite athletics competitions assessed by randomized-response surveys. Sports Medicine, 48(1), 211–219. (epub: August 2017). DOI: 10.1007/s40279-017-0765-4 REF2ID: 03-157-1148

- Funded by WADA through the Doping Prevalence Working Group
- Petróczi, A. & Nepusz, T. also reported the SSC method results, in a confidential report

R4 – James, R. A., Nepusz, T., **Naughton, D. P.**, & **Petróczi, A.** (2013). A potential inflating effect in estimation models: Cautionary evidence from comparing performance enhancing drug and herbal hormonal supplement use estimates. Psychology of Sport and Exercise, 14(1), 84-96. DOI: 10.1016/j.psychsport.2012.08.003

- This study design mirrored the WADA Prevalence Project [R3] with an additional prevalence estimation for comparison

R5 – Nepusz, T., **Petróczi, A.**, **Naughton, D. P.**, Epton, T., & Norman, P. (2014). Estimating the prevalence of socially sensitive behaviors: Attributing guilty and innocent noncompliance with the single sample count method. Psychological Methods, 19(3), 334-355. (epub: December 2013). DOI: 10.1037/a0034961.

- Linked to 2012-2014 MRC grant of GBP369,171.00 (Co-I)

R6 - **Petróczi, A.**, & **Naughton, D. P.** (2011). Impact of multidisciplinary research on advancing anti-doping efforts. International journal of sport policy and politics, 3(2), 235-259. DOI: 10.1080/19406940.2011.577083

4. Details of the impact

Assessing the prevalence of doping in high-performance sport is critically important, for public integrity and professional competition. Robust assessment informs evidence-based testing (of targeted athlete populations) and monitors the effectiveness of the anti-doping programmes over time. Petróczi's research has directly informed and improved WADA's priorities, policies, and practices, as well as affected guidance on data recording and reporting practices in the anti-doping community.

Informing WADA's priorities and policies

Petróczi's research recommendations directed the WADA's strategy for estimating doping prevalence, and for initiating and prioritising the Prevalence Project System-level doping scandals surfaced from 2013, peaking in mid-2015, leading to official investigations by WADA and government agencies. To address this problem, as a strategic priority, the World Anti-Doping Agency (WADA) initiated the Prevalence Project, with Petróczi as Working Group member (2011) then Chair (2017 – ongoing). Results from Petróczi's 2011-2012 Prevalence Project **[R3]** were used as evidence and publicly released by the House of Commons Culture, Media and Sport Committee in 2015, leading to a substantial reaction by the mainstream media, general public and professional athletes. The results are also cited and explored in the reflective 2018 Digital, Culture, Media and Sport Committee 'Combatting doping in sport' report highlighting problems around doping prevalence **[S1]**. The two studies at the IAAF 2011 World Championships (WC) in Daegu and the 2011 Pan Arab Games (PAG) in Doha were important in many ways. The two models applied yielded significantly different prevalence estimations **[R3, R4]**. The divergence between the results, which was probably and inadvertently caused by allowing athletes to take control over an element of the randomization, highlighted a strong need for improvement in the survey format, as well as the potential of the methodology for doping prevalence estimation **[S2]**.

In 2017, the WADA Working Group on Doping prevalence was re-established. Petróczi was appointed Chair, with the function to review, develop and implement tools for assessing doping prevalence **[S3]**. Petróczi's appointment was underpinned by her prolonged involvement in prevalence research and her ability to work effectively with colleagues in science and social science. The WADA's President and Director General's end of 2017 message made specific note of '*the assessment of the prevalence of doping'*. The Group work closely with WADA management and benefit from a dedicated budget ($255,000).

In 2019, consulting group PricewaterhouseCoopers were commissioned to independently review all the ongoing and future WADA's activities and to assess the impact of WADA's Research and Development portfolio. Recalling the outcome of this evaluation, the WADA Science Director said that '*PWC described the Prevalence Project as one of the essential projects not only for Science and Medicine but for anti-doping as a whole.*' He continued '*Thus, I consider the Prevalence Project as one of the higher profile within my portfolio – certainly within the three strategic projects under my responsibility*'. With field studies already underway, this project '*is essential*' because it is key to accurately assessing the cost-effectiveness of anti-doping programmes **[S3]**. The doping prevalence agenda, with its continuing research included as an output of the 2020-2024 Social Science Research Strategy for 'Contributing to Global Insight', underpins the evaluation and cost-effectiveness analysis of many other WADA activities and goals **[S4]**. Following from the Group's work, the capacity to assess and monitor the prevalence of doping in elite sport has become a key strategic project for WADA. The WADA Science Director stated that: '*Her [Petróczi's] work is a vital contribution to us and to the field of anti-doping research*' **[S3]**.

<u>Improving WADA's practices</u>

Based on Petróczi's research on the Single Sample Count method **[R2, R5]**, Petróczi led the working group in developing a survey-based tool. Her work on indirect estimation approaches highlighted the need for a better understanding of how features of these models impact on compliance and prevalence estimations, to ensure that important behavioural aspects are not ignored and that false positives are considered **[S5]**. Leading reviews on indirect estimation models, Petróczi identified the best model, and informed the work of optimising the final model, which is based on the Crosswise design **[S5]**. The meta-analysis of the crosswise model application showed that the difference in returned prevalence rates, increasing as the sensitivity of the investigated issue increased. This provided a clear rationale for the superiority of indirect estimation over direct questions.

One such model was carefully designed, repeatedly tested and validated – with Petróczi leading the proposals, survey designs, data collection protocols, onsite supervision or data collection and liaison, data analysis and report writing. The WADA Science Director commented how they have found there are '*lots of big advantages*', '*including the flexibility, low cost, anonymity and retrospectivity*' of the survey. As a result, the survey can be used across the world, regardless of infrastructure, as required by organisations with responsibility for anti-doping (e.g. National Anti-doping Organisations (NADOs), Regional Anti-Doping Organisation (RADOs) and Sport Federations, major event organisers), to assess the doping prevalence in targeted sports and nations **[S3]**. As a consequence, the WADA Science Director has proposed, trialled and adopted this survey as '*one of the key elements in the set of tools*' WADA uses to assess prevalence, complementing other insights and measurements **[S3]**.

The survey-based assessment of doping prevalence has been used at multiple major sport events since 2018. In three events - Gold Coast Commonwealth Games (2018), European Games (2019) and Pacific Games (2019) - the model developed in Kingston University [R6] played a key role in refining and validating the final survey tool **[S6]**. The Director of the WADA Latin American Regional Office, who met Petróczi at the 2019 Pan-American games in Lima and assisted with the implementation of the survey tool at that event (with over 2000 completions), has stated that: '*The Prevalence Project questionnaires were very well done: because they were brief and not invasive. They were accessible, both to individual athletes by their simplicity and to local NADOs because they are low-cost and do not require complex technology to process*' **[S7]**.

She goes on to note that her local NADOs will '*greatly value being able to re-assess and re-think testing strategies…and to maximise cost-effective testing and education*' **[S7]**. Having been successfully trialled, this approach was officially adopted for use by anti-doping organisations in November 2020; with WADA explaining that understanding doping prevalence reveals '*if we're performing well, bringing value to stakeholders and maximising the impact of anti-doping programs*'. **[S6]**

The Testing Manager of the AEPSAD, the Spanish NADO, has included the survey in AEPSAD's future strategy. Having detailed the anti-doping strategy to be implemented in the next two-year period, he explained that '*we need to use the survey to measure the efficiency of the measures before we introduce them, on the first and the second year. Also, as an additional piece of information, we were thinking to run the survey face to face in athletics in the National Championship outdoor to have a kind of comparison of results just for this specific sport*' **[S8]**. The survey has also been proposed to be in UKAD's future strategy from 2021.

The Doping Prevalence Index (DPI), a reliable and easy-to-use framework which combines the results of different doping prevalence measures, was developed by Petróczi and the Working Group. Petróczi's research had showed that combining methodologies advances anti-doping evidence gathering. By placing several tools together, the DPI overcomes the limitations associated with each measure individually and thus prevents potential statistical outliers from causing inaccurate estimations. The Senior Education Manager noted how Petróczi worked on '*the reliability of those tools, on making them available, and has also written papers **[S5, S9]** so that our stake holders can see the technical aspects of the tools*' and how an accurate DPI would be '*a big step forward in the field*' **[S10]**. Petróczi led an evidence synthesis review, conducted by the Expert Group on Doping Prevalence, which resulted in accepted recommendations to reporting annual WADA Laboratory Testing Statistics and guidance for reporting evidence for doping prevalence in published research outputs and reports **[S9]**. This will facilitate meta-analysis and future syntheses of evidence for doping behaviour. As part of this work, Petróczi also developed the set of quality assessment and bias criteria with a Kingston visiting student and members of the Working Group.
The DPI has been adopted by and is currently being tested by WADA **[S3, S6]** to analyse prevalence trends over time and to assess anti-doping programme effectiveness. It will show an accurate picture of doping prevalence globally, as well as in a country or at sport level.

5. Sources to corroborate the impact

S1 – Combatting Doping in Sport by the Digital, Culture, Media and Sport Committee, 2018
S2 – WADA Working Group Report regarding the discrepancy between prevalence estimations and potential problems with the indirect survey methodology
S3 – Testimonial by the WADA Science Director
S4 – WADA's Social Science Research Strategy 2020-2024
S5 – WADA Working Group Report regarding the Functionality of the Crosswise Model
S6 – WADA Webinar: An Update of the Development of Tools to Measure Doping Prevalence
S7 – Testimonial by the Director of the WADA Latin American Office
S8 – Testimonial by the Testing Manager of AEPSAD
S9 – WADA Working Group Report regarding Guidance for reporting doping prevalence data in published research reports.
S10 – Testimonial by the WADA Senior Education Manager