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Journal article

Developing additional competition classes for athletes with intellectual impairments: Conceptual approach and efficacy of an ICF derived measure

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1 **Developing additional competition classes for athletes with intellectual impairments: Conceptual**
2 **approach and efficacy of an ICF derived measure.**

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11

12 **Abstract**

13 The purpose of para sport classification systems is to minimise the impact of impairment on
14 competition outcome. Currently, athletes with intellectual impairment (II) compete in one class,
15 regardless of the extent of activity limitation resulting from their impairment. Consequently, athletes
16 with II that cause relatively minor difficulty in sport have a competitive advantage over athletes who
17 have intellectual impairments that cause more significant advantage. This research investigated the
18 efficacy of a measure of health-related functional impairment, derived from the World Health
19 Organisation International Classification of Functioning, Disability, and Health (ICF), as a tool to
20 classify athletes with intellectual impairments (II) into groups with impairments that cause similar
21 activity limitation. The first study used a Delphi technique to identify the most relevant codes within
22 the ICF from which a measure of impairment presence and severity was derived. The second study
23 investigated whether the measure could discriminate between groups of II athletes organised into
24 three competition groups, and whether these groups could be predicted by ICF score. The ICF based
25 questionnaire shows promise as a conceptual approach and as a tool in this context, but this is a
26 preliminary step before establishing a sport-specific approach to classification.

27

28 **Keywords**

29 Intellectual disability, Parasports, Virtus, Down Syndrome, Classification, ICF

30

31 **Introduction**

32 Athletes with intellectual impairments (II) compete in only one class within the three sports of

33 swimming, athletics and table tennis currently included in Paralympic competition. Eligible

34 impairment criteria concerns establishing that the athlete has the eligible impairment, in this case II.

35 This is the first step in Paralympic classification and is managed by Virtus World Intellectual

36 Impairment Sport (previously INAS). Virtus holds the status of an International Organisation of

37 Sports for the Disabled (IOSD), one of four such independent organisations recognised by the

38 International Paralympics Committee (IPC). As well as managing eligible impairment criteria

39 processes Virtus organises and promotes competitions within 16 sports through a network of five

40 regions and 86 member nations. Since 2009 Virtus has had a rigorous system to ensure that athletes

41 meet the diagnostic criteria of II. This system is endorsed by the IPC and once an athlete appears on

42 the Virtus master list they are deemed as meeting the eligible impairment criteria for IPC

43 competition. The definition of II adopted by both Virtus and the IPC is that of the World Health

44 Organisation (WHO) International Classification of Diseases, version 10 (ICD-10; World Health

45 Organisation, 2016)¹ which requires that athletes *'have a restriction in intellectual functioning and*

46 *adaptive behaviour which affects the conceptual, social and practical adaptive skills required for*

47 *everyday life. This impairment must be present before the age of 18.'* (p6 IPC International Standard

48 for Eligible Impairments, 2016). Intellectual functioning is measured by a formal assessment of IQ,

49 and adaptive behaviour is measured either by clinical observation or completion of a culturally

50 appropriate assessment. The age restriction is to ensure that impairment has occurred during the

51 developmental period and to distinguish between other conditions, such as acquired brain injury

52 later in life.

¹ ICD-11 was published in 2018 and the new terminology to be adopted is 'Disorders of Intellectual Development'. This will not come into full effect until 2022.

53

54 Once an athlete has been deemed, via Virtus, to meet the eligible impairment criteria a second step
55 is required to compete in IPC sanctioned events, this is to establish that the athlete's eligible
56 impairment '*meets the minimum disability criteria of the sport*' (IPC Athlete Classification Code,
57 2015). This process is managed by the International Sport Federation for each sport and is required
58 to be an evidence-based system consistent with the conceptual model underpinning the IPC
59 approach to classification (Tweedy & Vanlandewijck, 2011). These IPC classification procedures for II
60 athletes in the three included sports are now well evidenced and described (e.g. Van Biesen,
61 Mactavish, & Vanlandewijck, 2014; Van Biesen, Mactavish, Kerremans, & Vanlandewijck, 2016) and
62 the conceptual approach is described in the paper by Van Biesen, Burns, Mactavish, Van de Vliet and
63 Vanlandewijck (2020) in this volume. The third step within classification is to categorise an athlete
64 into a sports class which describes the athlete's limitations most accurately. This is to ensure that
65 athletes are competing against each other fairly, with similar levels of activity limitation. Within
66 Physical Impairment (PI) classification a sport may have multiple classes representing the level of
67 functional activity limitation, for example 10 classes in swimming (S1-S10), and likewise for Visual
68 Impairment (VI), which has three classes, (S11-S13). However, within II there is currently only one
69 sports class in all the three included sports, swimming (S14), athletics (T/F20) and table tennis
70 (TT11).

71

72 The reasons for this are multifactorial and include the need to grow competition to ensure there is
73 enough high-level competition to fill more than one class, the practical and financial constraints of
74 running multiple classes in qualifying and international events, and importantly, the current lack of
75 any system to classify athletes with II into distinct classes which is evidence based and is consistent
76 with the IPC conceptual approach. However, that there is only one class for II does represent an
77 equality and inclusion issue, and unless there are additional competition classes it is unlikely that

78 competition will grow. In 2016 the Virtus general assembly passed a motion to grow II sport by
79 developing additional competition classes within Virtus events. To enable this a research project was
80 established to investigate what an evidenced-based classification system to categorise levels of
81 activity limitation in athletes with II would look like. This paper sets out the Virtus conceptual
82 approach and initial findings of this project.

83

84 It is acknowledged that whilst keeping broadly to IPC-based principles this is a Virtus-based
85 approach, with the purposes of including a more representative range of athletes with II in Virtus
86 competitions, to test the ICF conceptual approach, and grow this competition group. This will
87 facilitate further research and refinement of the approach, which would be required before being
88 applicable within the context of IPC classification. As such this might be described as a staged
89 approach to facilitating athletes with a greater range of impairment severity to compete within
90 Virtus, which will not only expand the opportunities available for II athletes, but will also provide a
91 pool of competitors to facilitate further research to develop IPC compatible sport-specific
92 classification systems. Such a class, called within Virtus II2, differs from the IPC approach in that at
93 this stage it would be a unified class across sports, but as competition and research develops a more
94 sports-specific approach is anticipated. As Tweedy has previously suggested that a unified approach
95 to classification could be implemented through the application of the International Classification of
96 Functioning, Disability, and Health (ICF; World Health Organisation, 2001) framework, taking this
97 approach within this context appears an appropriate conceptual starting position (Tweedy, 2002).
98 Furthermore, common to the context of both Virtus and the IPC is the need for a sports classification
99 system to have a clear conceptual framework, a *'sound scientific and taxonomic basis'* and be
100 *'articulated using language and definitions that are unambiguous and internationally recognised.'*
101 (Tweedy, 2002).

102

103 **Taxonomy and II**

104 Statistically around 0.05 to 1.55 % of the world's population have II (McKenzie, Milton, Smith, &
105 Ouellette-Kuntz, 2016). This differs across countries, dependent upon factors such as poverty and
106 education, but generally it represents one of the largest types of disability grouping (World Health
107 Organisation, 2011). As such it is unsurprising that within this group there is significant variation in
108 causation, level and types of impairment and ultimately functional capacity. The challenge is to have
109 a taxonomy of II that represents this diversity. One approach, adopted by the ICD-10 (World Health
110 Organisation, 2004) and the Diagnostic and Statistical Manual for Mental Disorders (DSM; American
111 Psychiatric Association, 2015) (the two most commonly used taxonomic frameworks in this area) is
112 by differentiating functioning in terms of level of IQ. Four categories are usually described: mild (IQ
113 50-69), moderate (IQ 35-49) severe (IQ 20-34) and profound (IQ <20). This approach has been much
114 criticised on several fronts, including; IQ being just one element of II diagnosis; reliability of
115 measures, especially with more severe impairments; and overall IQ scores being a flawed concept
116 (Bertelli, Cooper, & Salvador-Carulla, 2018; Whitaker, 2015).

117

118 Many studies demonstrate the independence of specific cognitive functions from a single, global IQ
119 score (Johnson, Jung, Colom, & Haier, 2008). Indeed, this has been demonstrated in the
120 development of the sport-specific classification process in II, where not only has there been shown
121 to be a lack of correlation between overall IQ score and sports performance, but that specific types
122 of cognitive skill are implicated in performance (Gilderthorp, Burns, & Jones, 2018; Van Biesen et al.,
123 2016). Recent revisions of DSM-5 and ICD-11 have recognised this problem and both suggest that IQ
124 profiles based on neuropsychological testing across a range of domains are more useful than a single
125 IQ score.

126

127 A second serious criticism to this approach concerns the level of multi-morbidity in the population of
128 II. In a recent large cohort study (n=1,023) it was found that 99.2% of the sample had at least one
129 additional physical health condition, as defined using the International Statistical Classification of
130 Diseases and Related Health Problems, 10th revision (World Health Organisation, 2016) and 98.7%
131 had two or more conditions. In addition, the average number of additional health conditions
132 measured was 11, the highest number being 28 (Kinnear et al., 2018). Hence, multi-morbidity is the
133 norm within II, not the exception, and is present across the lifespan, unlike the general population
134 where it increases over the age of 50 (Kinnear et al., 2018). Many of the most common conditions
135 found in Kinnear et al.'s (2018) study would have a significant impact upon functionality, and
136 specifically sports performance, for example musculoskeletal (incidence 48.2%), circulatory (28.7%)
137 and respiratory (27.9%) problems. Given that II includes many sub-populations with specific
138 syndromes which contain a constellation of intellectual, sensory and physical health deficits (e.g.
139 Down Syndrome, Fragile X), such multi-morbidity should not be a surprise. For those without a
140 specific genetic causation, that trauma to the central nervous system, no matter what the aetiology,
141 has a wider impact than just cognitively also makes logical sense. However, what is perhaps not as
142 well acknowledged is the extent of this multi-morbidity, and consequently the need to consider the
143 reciprocal nature of these conditions during development. It is recognised within the research
144 literature that multiple deficits will have an additive, iterative and cumulative impact upon the
145 overall functioning of the individual (Karmiloff-Smith, 2009; Karmiloff-Smith, 2018). Hence, the
146 limitations an adult with II faces are not just a product of cognitive deficits, but a product of the
147 iterative combination of intellectual, sensory and physical deficits over the developmental period.
148 Indeed, the concept of 'intellectual impairment' as previously envisaged is coming under increasing
149 criticism (Misheva, 2018; Nakken & Vlaskamp, 2007).

151 A reading of the complex area of taxonomy within II, together with the clear disconnection between
152 unitary measures of IQ and sports performance, makes it clear that a simple approach to sports
153 classification of assuming a causal, linear relationship between IQ and sport performance (i.e. classes
154 based on IQ cut-off points) is flawed and inoperable. A more holistic approach is required which
155 considers the composite of factors which may lead to limited functional capacity.

156 **Conceptual Approach**

157 Consistent with sports classification, corresponding calls within educational and clinical contexts
158 have been made to make greater use of the international and comprehensive nature of the ICF
159 taxonomy when trying to characterise individuals with II (Simeonsson, 2009; Vale et al., 2017). Given
160 that the ICF taxonomy fits conceptually with sports classification and the growing awareness of the
161 complexities of assessment in II, in addition to the resources being freely available, downloadable,
162 recognised internationally and available in several languages, the ICF framework was adopted as the
163 underpinning model to develop further competition classes within the Virtus research programme.

164

165 As an initial exploration of this conceptual approach a previous study in the Virtus research
166 programme used the ICF checklist with different groups of II athletes to investigate the relationship
167 between IQ and functional impairment in athletes with II (Gilderthorp et al., 2018). The ICF checklist
168 is a short, generic measure recording both presence of the impairment and severity in terms of
169 impact on functioning (World Health Organisation, 2003). The finding that IQ was not related to
170 sporting performance found in previous studies (Van Biesen, et al., 2016) was replicated. The study
171 also replicated that, even within an II population engaged in sporting activity, the number of
172 additional health impairments present was related to IQ, such that the lower the IQ the higher the
173 number of comorbid conditions (Kinnear et al., 2018). However, the ICF checklist lacks sensitivity,
174 considers only broad level domains and does not include many of the health conditions experienced
175 by people with II. A more sensitive instrument is required to meet the requirements of Virtus sport

176 classification. Fortunately, the ICF taxonomy offers this opportunity by being able to select from the
177 1,400 ICF codes those most relevant to describe the condition under investigation.

178

179 **Aims and Hypotheses**

180 The Gilderthorp et al. (2018) study provided ‘proof of concept’ suggesting this ICF-based approach
181 has merit and further work was justified. Hence the aim of the research reported here was to refine
182 the approach to measuring global functional impairment using a wider selection of ICF codes and
183 further explore the relationships between impairment, IQ and competition groups, related to levels
184 of performance. The full ICF taxonomy is available in eight different languages and allows relevant
185 codes, up to four levels of specificity, to be downloaded into a bespoke questionnaire, more
186 nuanced to the impairments relevant to II. Impairments are coded as present or not, but
187 importantly the degree to which it is perceived they impact on functioning (severity) is also
188 recorded. The Delphi study reported here focussed on selection of the most appropriate codes to
189 form an ICF questionnaire, which will measure the presence and severity of the most common
190 health conditions experienced by people with II, for use as a possible tool in Virtus classification.

191

192 It is estimated that 20% of the ICF codes will explain 80% of the variance observed in practice, and
193 for this reason ‘core sets’ have been developed (Ustun, Chatterji, & Kostanjsek, 2004). Core sets are
194 a group of codes which have gone through a rigorous, testing and selection process to be able to
195 efficiently describe an individual’s level of functioning within a specific health condition e.g. stroke,
196 spinal cord injury. However, currently there is no core set which refers specifically to II, hence we
197 needed to select from the 1,400 codes the most relevant to describe this group. A Delphi approach
198 was taken as it uses an expert panel to identify fundamental elements of a phenomenon, through a
199 process of consensus agreement (Brady, 2015).

200

201

202 Athletes with II are likely to lie on a continuum, with at one end the Virtus athletes, performing at
203 the highest standard and at the lower end those with the greatest physical impairment
204 demonstrating significantly lower performance. Below Virtus athletes will be athletes with Down
205 Syndrome (DS) who will also be spread along this continuum, but at a lower range than Virtus
206 athletes. The aim of study two was to field test the devised ICF questionnaire and examine if it was
207 able to discriminate between three groups of athletes: Virtus athletes, presumed to be performing
208 at the highest level and hypothesised to have the least additional health impairments; DS athletes,
209 presumed to be competing at the lowest level and hypothesised to have the most additional health
210 impairments; and a group of athletes competing at regional level, hypothesised to fall between the
211 other two groups.

212

213 Athletes with DS very rarely compete in the original II class at Virtus events, their world record times
214 are lower across a range of events and they are known to have a range of comorbid health
215 conditions likely to affect athletic performance, such as respiratory and muscular limitations. Given
216 that 15-20% of all people with II have DS, it makes sense that in this first step of developing a second
217 competition class Virtus wants to make sure it includes athletes with DS. However, a measure of
218 equivalence is required to include other athletes with a similar level of functional impairment into
219 this class, such that it is a class for those with more significant impairment, who can compete at a
220 similar level, and not be based on medical diagnosis. To examine this a third comparative group was
221 selected who do not have DS, who train and compete, but not at the international level. It was
222 considered that this group would have the differing levels of impairment ranging from within the
223 range of Virtus athletes to overlapping with the DS group. However, it might not be expected that
224 their impairment level would be worse than those with DS, as DS carries with it significant associated
225 health conditions. These three groups are named respectively Virtus, Regional and DS with regard to
226 their competition grouping and presumed sports performance level. If found to have discriminant

227 validity the questionnaire will be used in further research examining ICF scores in relation to sporting
228 performance, and to investigate if cut-off scores can be used reliably as a component of Virtus
229 competition classification.

230

231 Due to their highly interlinked nature, two studies are reported in this paper. The first was a Delphi
232 study to determine the choice of items to include in the bespoke ICF questionnaire, the second was
233 to field test this questionnaire, to establish its sensitivity and discriminant validity, and address the
234 following hypotheses:

- 235 1. The hierarchy of competition grouping would be replicated in relation to levels of impairment,
236 such that athletes in the Virtus group would have relatively low level of impairment, compared
237 to the Regional and DS groups, and the DS group have the highest level of impairment.
- 238 2. ICF scores would be a better predictor of group membership than IQ.

239

240 **Materials and Methods**

241

242 **Study 1- Delphi study to select relevant ICF codes**

243

244 **Participants**

245 The inclusion criteria for the expert panel were: experience of caring for, or working with people
246 with II (preferably athletes); good spoken and written English; and experience across the three
247 groups of athletes included in study 2. Thirteen people were approached via email to complete the
248 questionnaire, and eleven responded (Table 1), representing six different nations. These were
249 people known through Virtus, the Special Olympics and research networks.

250

251

252 Table 1

253

254 *Details of the expert panel*

<u>Job title</u>	<u>Experience</u>	<u>Gender</u>
Carer representative	Mother of a Virtus (INAS) athlete	Female
Virtus (INAS) Athlete representative	Registered with Virtus since 2011.	Female
Commissioning Manager – Intellectual Disabilities	Service provider for people with II and supporter of II athletes.	Male
PhD student	Working in health and II and coach in the Special Olympics.	Male
Lead researcher	Working in II and sport.	Female
Researcher	Working in II and sport.	Female
Member of Virtus (INAS)	Coach of athletes with II	Male
Member of Virtus (INAS)	Working in II and sport	Female
Researcher in sport, health and II	Researcher and coach with athletes with II	Male
Psychiatrist	Working in eligibility for athletes with II	Female
Consultant Clinical Psychologist	Specialist in II	Male

255

256

257 **Measures**

258 To gather feedback from the expert panel, an online questionnaire was developed using Qualtrics
259 (version January 2017). The 114 level 1 Body Functions categories in the ICF were reviewed and
260 reduced to 31 selected from the research literature as most relevant (those most likely to have an
261 impact on athletic performance) for athletes with II. This excluded categories under: voice and
262 speech functions; genitourinary and reproductive functions; and functions of the skin and related
263 structures, as these tend to be less relevant when considering the functional impact on sport.
264 Mental health codes were also excluded as they related to mental health issues or intellectual
265 functions already covered by a diagnosis of II. Whilst this reduction in codes was completed in
266 advance of presentation to the Delphi panel, given the content of the excluded codes, not already
267 covered by a diagnosis of II, their lack of significant impact on sports was felt not to be controversial,

268 and assessing all the codes was too large a task for the panel to complete. The validity of this
269 approach was checked by providing the panel the opportunity to identify areas not covered.

270

271 **Procedure**

272 This procedure was based on the initial stages used to develop ICF Core Sets (Selb et al., 2015). The
273 expert panel were emailed the Qualtrics questionnaire and asked to rate the commonality of each
274 problem area from zero (very rare) to 100 (very common). They were also asked how easy they
275 found it to answer each question, from one (extremely easy) to five (extremely difficult) to get a
276 measure of how accessible the items were. The panel were invited to comment on any additional
277 health issues they thought were missing. Following analysis of the findings from round one, the
278 questionnaire was reviewed and sent back to the expert panel for further comment. Final consensus
279 on the inclusion of items was reached without the need for a further Delphi round.

280

281 **Results**

282 The lowest reported item was, "*Problems relating to sensing temperature and other stimuli*" (M =
283 14.00, SD = 8.72), and the highest was, "*Problems with joint mobility*" (M = 43.50, SD = 33.69). The
284 panel judged all items to be common to more than 10% of people with II and so all items were
285 included to maximise the comprehensiveness of the measure. None of the results suggested any
286 items were difficult to answer. The items fell into three ICF domains; senses and pain; the heart,
287 lungs and immune system; and movement and mobility. Following comments from the panel, a
288 further three questions were added to cover issues with obesity and epilepsy. This included energy
289 and drive (b130), weight maintenance (b530), taken from the ICF Core Set on Obesity (Stucki et al.,
290 2004) and consciousness (b110) taken from previous research on epilepsy using the ICF
291 (Cerniauskaite et al., 2012). The complete questionnaire consisted of 35 items.

292

293 **Study 2 – field testing the ICF questionnaire**

294

295 **Participants**

296 Inclusion criteria for participants across all three groups included: being over age 18; participation in
 297 a sport event in the last 12 months; being able to provide informed consent; being accompanied by
 298 an English-speaking supporter, familiar with the athlete and their medical history and able to act as
 299 translator if required; and meeting the Virtus IQ eligibility criteria of a full scale IQ of 75 or below.

300 Inclusion in the Virtus group was by merit of being a Virtus athlete (i.e. qualified to compete at Virtus
 301 sanctioned international events). Inclusion in the Regional group was by having competed no higher
 302 than regionally in any II sporting event, were not Virtus registered athletes and recruited through
 303 Special Olympic and Mencap² events. Inclusion in the DS group was through a diagnosis of DS.

304

305 Overall, 116 athletes agreed to take part in the study. Fourteen athletes were excluded: three who
 306 were under 18; seven who scored above 75 on the WASI-II IQ screening assessment; one when it
 307 became apparent they did not have II (they were at university); one who did not complete the
 308 interview as they were upset about losing their match; and two who completed the WASI-II but did
 309 not respond to follow-up. This gave a sample size of 102. Details on the demographics of the
 310 athletes are included in Table 2. The majority of interviews took place in person, with eight Virtus
 311 athletes interviewed remotely. The DS group consisted of 23 athletes with trisomy 21 (72%), one
 312 athlete with mosaicism (3%) and one with translocation (3%). Information on the type of DS was
 313 unknown for seven (22%).

314 Table 2

315

316 *Characteristics of participating athletes*

		Athlete group (N = 102)		
		Virtus (n = 44)	Regional (n = 26)	DS (n = 32)
Gender	Female (%)	16 (36.4)	13 (50.0)	10 (31.3)
	Male (%)	28 (63.6)	13 (50.0)	22 (68.7)
<u>Nationalities</u>	American (%)	3 (6.8)	0	0

² A UK charity providing sports events for athletes with II

	Australian (%)	16 (36.4)	2 (7.7)	1 (3.1)
	Belgian (%)	2 (4.5)	0	0
	British (%)	14 (31.8)	17 (65.4)	25 (78.1)
	British/Caribbean (%)	1 (2.3)	0	0
	British/Indian (%)	0	1 (3.9)	0
	British mixed (%)	0	0	2 (6.3)
	Chinese (%)	3 (6.8)	6 (23.1)	0
	Czech (%)	1 (2.3)	0	0
	French (%)	3 (6.8)	0	4 (12.5)
	German (%)	1 (2.3)	0	0
Ethnicity	Aboriginal/White Australian	2 (4.6)	0	0
	Black British (%)	0	1 (3.9)	0
	Black British/Caribbean (%)	1 (2.3)	2 (7.7)	0
	British/Indian (%)	1 (2.3)	1 (3.9)	0
	Chinese (%)	4 (9.1)	6 (23.1)	0
	White Australian (%)	12 (27.3)	2 (7.7)	1 (3.1)
	White British (%)	13 (29.5)	12 (46.2)	24 (75.0)
	White European (%)	7 (15.9)	0	5 (15.6)
	White Irish (%)	0	1 (3.9)	0
	White Other (%)	4 (9.1)	0	1 (3.1)
	Mixed (%)	0	1 (3.9)	1 (3.1)
Competing sport	Athletics (%)	8 (18.2)	6 (23.1)	0
	Basketball (%)	11 (25.0)	3 (11.5)	0
	Boccia (%)	0	1 (3.9)	1 (3.1)
	Cricket (%)	7 (15.9)	4 (15.4)	0
	Cycling (%)	1 (2.3)	0	0
	Equestrian (%)	0	2 (7.7)	0
	Football (%)	0	0	1 (3.1)
	Netball (%)	0	2 (7.7)	1 (3.1)
	Power lifting (%)	0	1 (3.9)	0
	Swimming (%)	4 (9.1)	4 (15.4)	27 (84.4)
	Table tennis (%)	4 (9.1)	3 (11.5)	0
	Tennis (%)	9 (20.5)	0	0
	Ten pin bowling (%)	0	0	2 (6.3)

317

318

319 **Measures**320 **Functional Impairment**

321 The ICF-based questionnaire as developed in study one was used to measure functional impairment.

322 Where necessary, given that the questionnaire was to be administered to athletes with II and those

323 caring or working with them, the wording of the questions was adapted from the ICF to provide

324 prompts in simpler language. The item was given in its simple format first e.g. do you have any heart

325 problems, and if an issue was found to be present this was then explored in more depth using both
326 accessible and technical language (e.g. does your heart beat too fast sometimes (tachycardia)?). An
327 interview protocol was developed so that the questionnaire was administered in a standardised way
328 and providing standard ways of explaining some health conditions. If the athlete identified that they
329 experienced the health problem they were asked to gauge the extent of the problem (severity),
330 using an accessible scale adapted from the ICF Checklist (WHO, 2003). 'No problem' was scored as
331 zero, going up to a score of four for 'Complete problem', giving the possible range of scores as 0-140.
332 Relevant demographic information was also collected.

333

334 Versions of the ICF-based questionnaire were created in German, French, Spanish and Finnish using
335 the WHO online tool (<http://www.icf-core-sets.org/en/page0.php>). Whilst these used the original
336 ICF language, they proved to be a useful reference for athletes and their supporters to check any
337 medical terms they did not recognise. Further minor revisions were made in the early stages of data
338 collection following feedback from interviews, involving changing some minor additions to the
339 prompts, e.g. control of voluntary movement was broken down further to include fine motor skills.
340 The athlete was interviewed in the presence of a supporter, which was often their coach or a family
341 member, who assisted the athlete to understand the questions being asked and provided additional
342 information if required.

343

344 **Intellectual impairment**

345 The Wechsler Abbreviated Scale of Intelligence, Second Edition (WASI-II) was used to help ensure
346 that the athlete met the criteria of having an IQ of 75 or below. It is a brief screening tool which can
347 be used for research, but not for diagnostic purposes (Wechsler, 2011). It is a well validated and
348 reliable tool based on the Wechsler family of IQ assessments. The two-subtest version was used in
349 this study consisting of the Vocabulary and Matric Reasoning subtests. This provides a Full-Scale IQ
350 (FSIQ) estimate, where the average score in the general population is 100. As Virtus athletes are

351 required to pass the rigorous eligibility procedure, their FSIQ data was accessed through the Virtus
352 records so it was not necessary to administer the WASI-II to this group.

353

354 **Post-questionnaire interview**

355 As part of the field testing to evaluate the ICF-based questionnaire, a short post-questionnaire was
356 administered generating information about the ease of use of the questionnaire.

357

358 **Procedure**

359 Event organisers through Virtus, the Special Olympics and Mencap were approached for permission
360 to attend events and were sent details about the research and what would be required. Nine
361 sporting events were attended, including a European event in the Czech Republic and the Virtus
362 Global Games in Brisbane. In addition, 10 clubs and training events were visited in England, France
363 and Hong Kong. Coaches, parents and athletes were approached prior to, and at the events, and
364 given information sheets. If they were interested in taking part a suitable time was arranged to meet
365 them in a private space. After reviewing the information sheet, answering any questions about the
366 research and seeking consent, the athletes were verbally administered the ICF-based questionnaire,
367 followed by the post-interview questionnaire. Non-Virtus athletes were also asked to complete the
368 WASI-II, which they could choose to complete before or after the ICF-based questionnaire. If
369 athletes wanted to participate but were not able to at an event the opportunity to conduct the
370 interview virtually was offered. The WASI-II was always conducted face-to-face, with a translator
371 present if required.

372

373 **Data Analysis**

374 Data analysis was conducted using SPSS statistical analysis software, version 23 (IBM Corp, 2015).

375 Additional effect sizes were calculated using formulas in Field (2013). An initial analysis was

376 conducted on the demographic data to check for differences between the three groups. For the

377 categorical variables (gender; health problems; medication; assistive devices) a Pearson Chi-Square
378 was used. For the others (age; years competing) a one-way independent analysis of variance
379 (ANOVA) was used. Where significant results were found, post-hoc pairwise comparisons were
380 conducted to look for differences between the groups. Given the number of potential comparisons,
381 the Bonferroni adjustment was chosen to control for Type 1 errors.

382

383 The reliability of the ICF-based questionnaire was analysed using Cronbach's alpha. The ICF scores
384 were treated as ordinal data, as the difference between the values may not have been equal. Due to
385 this, and the positive skew to the ICF scores, the non-parametric Kruskal-Wallis test was used to
386 analyse the ICF scores by group to test the hypothesis that impairment would vary by group.
387 Pairwise comparisons were conducted on significant effects, to identify what group difference(s)
388 were driving this. Following Field (2013), Bonferroni-adjusted p -values were reported.

389

390 To establish whether there was a difference in IQ between the groups, and therefore whether it
391 should be controlled for, a one-way between participants ANOVA was conducted. Due to the
392 differences in sample sizes, post-hoc comparisons were conducted using Gabriel's procedure (Field,
393 2013). A multinomial logistic regression was then conducted, with groups as the outcome variable. A
394 power calculation was conducted to determine the necessary sample size, giving a target of 31
395 athletes in each of the three groups (Field, 2013; $N=92$). This was calculated using a medium effect
396 size and five potential predictors (IQ, ICF-based questionnaire score, age, gender, and number of
397 years competing). To more directly test the hypothesis that a measure that considers functional
398 impairment (i.e. the ICF-based questionnaire) will be able to better predict group membership than
399 IQ alone, the multinomial logistic regression was conducted using just IQ and ICF score as variables.
400 As the multinomial logistic regression did not include all three possible pairwise comparisons
401 between the groups it was followed by three binary logistic regressions, in which the dependent
402 variable of group was respectively 'Virtus vs. DS', 'Regional vs. DS', and 'Virtus vs. DS'. In each of

403 these regressions, IQ was entered as the sole predictor in the first model, while IQ and ICF score
404 were both predictors in the second model, such that a significant improvement in model fit from the
405 first to second models would indicate that ICF and IQ together better predicted group membership
406 than IQ alone.

407

408 **Results**

409 *Qualitative feedback on the ICF-based questionnaire*

410 All athletes completed the full ICF-based questionnaire and post-interview questionnaire The results
411 of the post-interview questionnaire showed that in terms of accessibility and the respondent
412 experience, the ICF-based questionnaire seemed to work well, and despite the medical terminology
413 attached to some of the items, with the additional supporting material, most respondents
414 demonstrated a good understanding of the questions. The combination of the interviewer aided by
415 the supporter was positive and was inclusive of the athlete with II which was appreciated by them.

416

417 *Group homogeneity*

418 IQ information was missing for four of the Regional athletes and three of the DS athletes. There was
419 no significant difference in gender balance across the three groups ($\chi^2(2, N = 102) = 2.25, p = .325$)
420 or across the groups for age ($F(2,99) = 1.57, p = .219$), number of years competing in their current
421 sport ($F(2,99) = 1.21, p = .304$), and years competing overall ($F(2,99) = .80, p = .452$), suggesting the
422 three groups are comparable on these variables.

423

424

425 The use of assistive devices (glasses and hearing aids) significantly differed across the groups, and
426 whether the device could be worn during sport. Post-hoc comparisons found significant results on
427 these variables between the Virtus and other groups for assistive devices. These comparisons also
428 highlighted a greater similarity between the Regional and DS groups when compared with the Virtus

429 group, indicating less reliance on such devices for the Virtus group. Athletes were also asked if they
 430 were currently suffering any health problems. Whilst there was a trend for less issues reported in
 431 the Virtus group Bonferroni-adjusted post-hoc comparisons showed no significant differences
 432 between the groups.³

433

434 *Testing hypothesis 1: The hierarchy of competition grouping would be replicated in relation to levels*
 435 *of impairment, such that athletes in the Virtus group would have relatively low level of impairment,*
 436 *compared to the Regional and DS groups.*

437 Using all 35 problem-related items on the ICF-based questionnaire gave an acceptable internal
 438 consistency, Cronbach's $\alpha = .75$ (Field, 2013). This suggested a sum of all the individual item scores
 439 (the 'ICF score') could be used in the analysis related to hypothesis 1. As shown in Table 3, the DS
 440 group had the largest mean ICF score, and the Virtus group the lowest. The ICF score significantly
 441 differed across the groups. Post-hoc comparisons showed a significant difference between the Virtus
 442 and DS groups, but no other significant group differences (see Table 3 and Figure 1). It should be
 443 noted that the effect sizes indicate a medium to large effect for the Virtus-DS group comparison, but
 444 a small effect for the others.

445

446

447 Table 3

448

449 *Comparisons between the three groups of athletes on the ICF-based questionnaire total score, using*
 450 *an independent samples Kruskal-Wallis test, and the effect size (r) of post-hoc comparisons*

Group	n	M (SD)	H(2)	r
Virtus	44	6.09 (7.75)		
Regional	26	8.58 (7.57)		
DS	32	11.72 (7.49)		
Total	102	8.49 (7.92)	14.49**	
Virtus v Regional				-.20

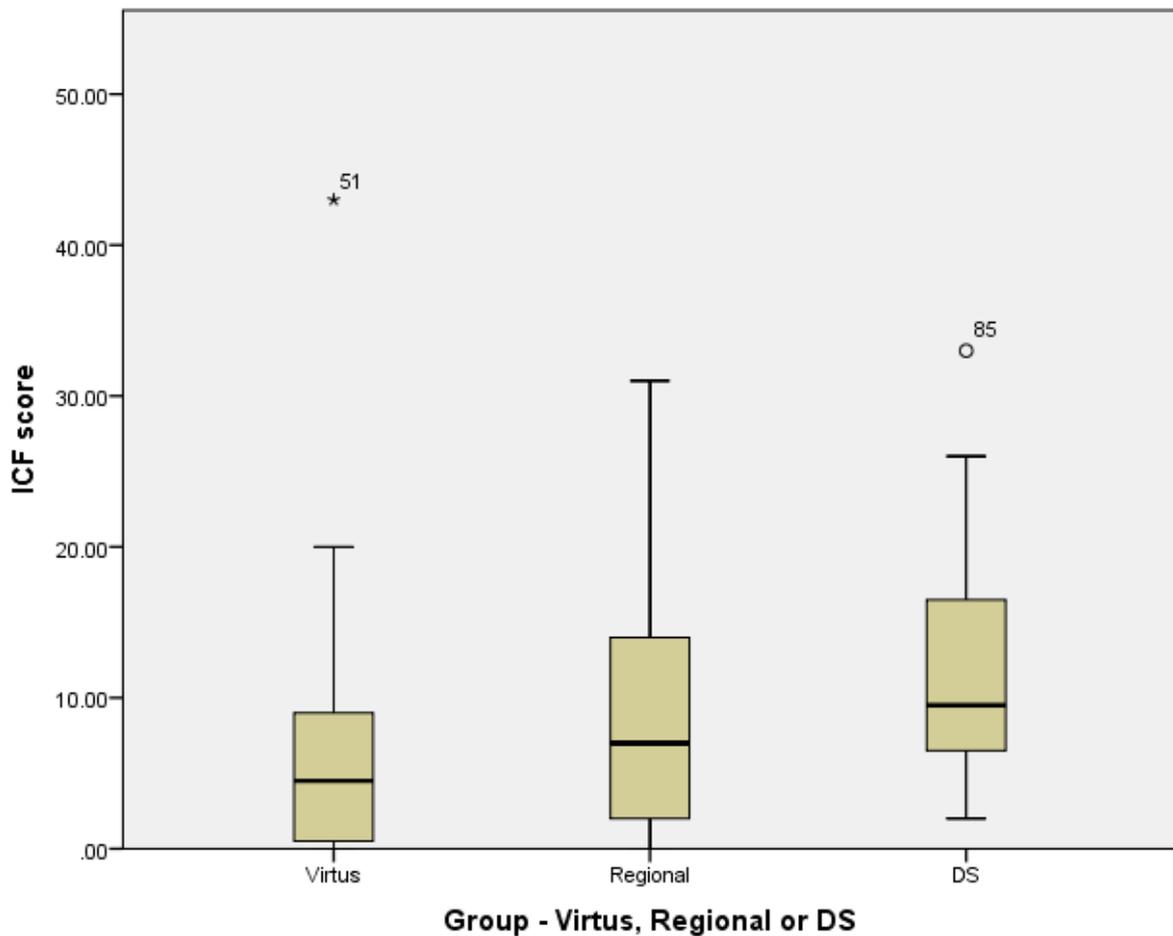
³ Please refer to Figshare for full analysis

Virtus v DS -.44**

Regional v DS -.23

451 * $p < .05$ ** $p < .01$

452



453

454 *Figure 1 ICF scores across the three groups*

455

456 *Testing hypothesis 2: ICF scores would be a better predictor of group membership than IQ.*

457 As shown in Table 4, IQ significantly differed across groups, with post-hoc comparisons revealing

458 that the DS group had significantly lower IQ than both the Virtus and Regional groups (both $p <$

459 $.001$), while the Virtus and Regional groups did not significantly differ ($p = .868$).

460

461 Table 4

462

463 *One-way ANOVA comparisons between the three groups of athletes on IQ*

Group	n	M (SD)	F(2, 68)	r
Virtus	44	62.27 (7.85)		
Regional	22	63.68 (8.41)		
DS	29	52.76 (7.73)		
Total	95	59.70 (9.14)	16.13*	.26

464 * p < .001 r=effect size of post hoc comparisons

465

466 A multinomial logistic regression was conducted with IQ and ICF score as the predictors and group
 467 (Virtus, Regional and DS) as the dependent variable (Table 5). This revealed that, even when IQ was
 468 included in the model, ICF score was a significant predictor of group membership, at least with
 469 respect to discriminating between the Virtus and DS groups. A significant improvement in fit was
 470 found for the binary logistic regressions predicting 'Virtus vs. DS' ($X^2(1)=5.05$, $p=.025$) and 'Regional
 471 vs. DS' ($X^2(1)=3.86$, $p=.049$), but not for the regression predicting 'Virtus vs. Regional' ($X^2(1)=0.90$,
 472 $p=.342$).

473

474 Table 5

475

476 *Multinomial logistic regression predicting group membership, with Virtus as the reference group*

	b (SE)	95% CI for Odds Ratio		
		Lower	Odds Ratio	Upper
Regional vs. Virtus				
Intercept	-2.51 (2.18)			
Total ICF score	0.04 (0.04)	0.97	1.04	1.12
IQ score	0.02 (0.03)	0.96	1.03	1.10
DS vs. Virtus				
Intercept	6.94 (2.20)**			
Total ICF score	0.09 (0.04)*	1.01	1.09	1.18
IQ score	-0.14 (0.04)**	0.81	0.87	0.94

477 Amount of variation in the dependent variable explained by the model: $R^2 = .30$ (Cox & Snell), .34
 478 (Nagelkerke).

479 Model $X^2(4) = 34.16$, $p < .001$.

480 *p < .05 **p < .01

481

482

483

484 **Discussion**

485 The purpose of the two studies was to a) compose an ICF-based questionnaire that represents
486 health impairments commonly associated with II which may impact on sports performance and b) to
487 test the sensitivity and discriminant validity of this new ICF questionnaire, and its ability to predict
488 group membership of three levels of sport competition. The Delphi study suggested a good level of
489 agreement between the expert panel in relation to the health issues to be included. In terms of the
490 administration of the test, involving both the athlete, an informed supporter and, where necessary,
491 a translator, this worked well and feedback from the participants was positive. Despite the quite
492 medical nature of some of the terminology used in the items, the protocol of having standardised,
493 simplified explanations, and the questionnaire being available in several languages certainly
494 facilitated the administration and suggests face validity. The internal robustness of the questionnaire
495 met the required standards to use a total score and the range of scores demonstrated no floor or
496 ceiling effects.

497

498 The hypothesis that the hierarchy of competition grouping would be replicated in relation to levels
499 of impairment, such that athletes in the Virtus group would have relatively low level of impairment,
500 compared to the Regional and DS groups was supported. However, the findings regarding the ICF
501 score discriminating between specific pairs of groups are worth treating somewhat tentatively at this
502 stage, both because the significant findings may be a Type 1 error, as the chances of this have been
503 inflated by multiple comparisons, and because the non-significant finding may be a Type 2 error,
504 arising from the relatively small sample size. Nevertheless, the finding of a distinction between the
505 DS group and Virtus group does seem to be a robust finding and replicates that of Gilderthorp et al.
506 (2018), using the less refined ICF checklist. Whilst significant differences are not proven between all
507 three groups, the order of level of impairment associated with the three competition groupings and
508 likely hierarchy of performance levels is promising.

509

510 In order to re-test the assumption that IQ is not related to competition group membership
511 differences in IQ scores between the three groups were examined and there was no significant
512 difference in IQ between the Virtus and the Regional groups, confirming this assumption. That IQ
513 was significantly lower in the DS group is not surprising given that other studies have reported
514 similar findings when comparing participants with DS to those with II and unknown aetiology (e.g.
515 Memisevic & Sinanovic, 2014; Patterson, Rapsey, & Glue, 2013). Research into the early
516 development and cognitive profile of children with DS also suggests that primary cognitive deficits
517 lead to impaired secondary cognitive gains and deterioration in IQ over the developmental timeline
518 (Karmiloff-Smith et al., 2016). As hypothesised ICF total score was found to be a better predictor of
519 group membership than IQ for the Virtus and DS groups. We would also suggest that the overall
520 finding that ICF score is useful in predicting group membership even when IQ is accounted for is
521 robust, and certainty sufficient to justify further research examining the ability of ICF scores to
522 predict the performance of athletes with II.

523

524 Conceptually, it is encouraging that the questionnaire distinguishes between the three groups as
525 hypothesised, albeit reliability needs to be improved. Most important is that the questionnaire
526 reliably distinguishes between the Virtus and the DS groups, as it is equivalence to those athletes
527 with DS which is currently being sought so that athletes with a similar level of functional impairment
528 are grouped with DS athletes in Virtus competitions. In relation to the lack of contrast between the
529 Virtus and Regional groups it is acknowledged that assumptions exist about the membership of
530 those in the Regional group, such as they could not perform at an elite level, which might be an
531 artefact of opportunity and training and not related to their actual potential and related health
532 impairments. In addition, assumptions were made about contextual issues, such that the athlete in
533 the Regional group may have elite potential, but through their financial or cultural situation

534 advancement to international competition was not possible. This is a limitation which could have
535 been better controlled for by applying stricter entry criteria into this group in relation to time
536 engaged in sport and training history, to screen out athletes who may be early in their careers and
537 their full potential not tested. Future research might concentrate on developing a comparator group
538 of II athletes whose optimal performance levels are known not to reach international standards.
539 Greater variety might also be expected from a non-matched sample and greater control over the
540 selection into this group might have provided a sharper contrast in level of impairment and validity
541 of the implied performance level.

542

543 Further work needs to be completed before a Virtus classification structure can be implemented and
544 cut-off figures confirmed. In terms of the fit with the conceptual model it would be helpful to
545 examine the relationship between the ICF questionnaire and actual sporting performance, as it is
546 expected that there should be a negative correlation between questionnaire scores and sporting
547 performance. Likewise, as another form of construct validity, one might expect a positive
548 relationship between reliable adaptive behaviour measures and the ICF questionnaire, as impaired
549 overall functioning should impact on adaptive behaviour, which also may account for some of the
550 variability found between the association between IQ and adaptive behaviour (Murray, McKenzie, &
551 Murray, 2014).

552

553 Once the reliability of the questionnaire is established and it is judged 'fit for purpose' from a
554 research perspective, various operational hurdles must be surmounted in terms of how it is used in
555 practice. Within Virtus it is expected that all those applying to II2 will come through the II1 eligibility
556 procedures, to confirm the presence of II, and then apply to enter the II2 class, to demonstrate
557 additional significant impairment. One issue is how to safeguard against intentional
558 misrepresentation. One approach, given that the questionnaire aims to identify increased functional

559 impairment through the presence of additional health issues, is to use it as a screening
560 questionnaire, and a confirmatory step of requiring medical proof for those issues identified is
561 included. This could be further enhanced through research using in-competition observation,
562 previous performance records and use of the Virtus eligibility data which all Virtus competitors will
563 have as a consequence of going through II1 eligibility, i.e. IQ and adaptive behaviour data. Other
564 operational challenges lie in the training and quality assurance of assessors and the infrastructure
565 required to operate the system.

566

567 Research is in progress to advance the development of the questionnaire to further test its validity
568 and relationship with sports performance, with the aim of setting cut-off scores to enable the
569 piloting of a wider II2 Virtus class, and as a result invite a wider range of athletes with II to
570 participate in international sport. Once such competition classes are established it will be possible to
571 embark upon the work to establish sport-specific classification procedures consistent with the IPC
572 requirements. As set out in the IPC position statement process-focussed research must develop
573 *'objective, reliable methods for measuring both of the core constructs – impairment and activity*
574 *limitation'* (Tweedy, & Vanlandewijck, 2011, p267). This paper has set out a conceptual approach to
575 measuring impairment within the context of developing an additional Virtus competition class,
576 further research will look at the utility of this approach in measuring activity limitation. These are
577 incremental steps in a programme of work to establish additional competition classes in Virtus, and
578 in the longer term develop sport-specific approaches to classification suitable for the further
579 expansion of international competition opportunities for athletes with II both within Virtus and IPC
580 sanctioned events.

581

582

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