DOI 10.2478/afepuc-2022-0001

COVID-19, PUBLIC HEALTH STRATEGIES AND POST PANDEMIC AAS/ANDROGEN USE: A COMMENTARY/SHORT COMMUNICATION

Philippe Crisp, Jamie Sims

University of Chichester, Institute of Sport, Nursing and Allied Health, United Kingdom

Summary: In this commentary/short communication we summarize many recent developments related to public health strategies for COVID-19. At this time, there are a wide range of emerging themes post various lockdown measures that have been reported, such as increased exercise, increased drug use, and various associated declines in mental health and other deleterious effects on eating behaviour patterns. Aligned to this, AAS/Androgen use has increased during and post-lockdowns and we posit, in the context of the aforementioned additional risks that have been reported, that future public health strategies need to demonstrate awareness of increased risk that they (AAS/Androgens) present at this time.

Key words: Mental Health; Body Image; Image and Performance Enhancing Drugs*;* Disordered Eating; Anabolic-Androgenic Steroids (AAS) /Androgens

Introduction

There has been significant success, in terms of vaccine development and the instigation of various other public health measures, at mitigating the scale of transmission, cases, deaths, and areas affected by coronavirus disease 2019 (COVID-19). However, despite a concerted effort from many countries to instigate vaccination programmes and subsequent lowered levels of infection fatality rate (IFR), COVID-19 continues to present a significant risk. In higher-income countries, this is now largely because of the potential surfacing of new variants that present challenges in terms of avoiding existing immunization responses (much developed through vaccination programmes) and thus making it more transmissible. At time of writing, Omicron (first identified as the variant B.1.1.529 and designated a variant of concern by the WHO) is one such variant that led to fast responding changes of government measures. In

England, for instance, travel bans, increased PCR testing, changes in isolation rules, and the reintroduction – in line with the other home nations of the UK that had not relaxed rules previously – of facemasks in shops and public transport were quickly reimplemented. And more substantially, in the UK as a whole, the UK COVID-19 vaccination programme was rapidly accelerated to include booster doses for all adults, and second doses for 12 – 15 year olds (JCVI 2021).

While we recognise the clear and present need to focus on addressing the requirement to ensure an equitable global roll-out of the vaccine initiative continues to be implemented in order to reduce virus circulation, we advocate a prospective focus on groups who are likely to continue to be at higher risk of severe outcomes subsequent to COVID-19 infection. As the virus transitions from pandemic to endemic (Antia & Halloran 2021), public health efforts will need to allocate resources to protect specific groups known to be at added risk. The NHS identifies certain groups likely to be at added medical or societal risk, including the elderly, those with chronic diseases affecting respiratory or cardio-vascular function, individuals with obesity or diabetes, those with mental health issues or intellectual disabilities, and people with compromised immune response (NHS 2021).

We believe that this latter group, including those with HIV/AIDS, Down's Syndrome, splenectomy, or on medication that reduces immune function, should also include those engaged in anabolic-androgenic steroids (AAS) /Androgen use. In this context then, we revisit our prior work detailing one facet of public health strategy, that of minimising AAS/Androgen use for health reasons, and in particular our assertions that AAS use can exacerbate health issues related to COVID-19 infection. Moreover, we extend our argument to include more recent evidence detailing other potential impacts on AAS/Androgen use that is emerging post lockdowns.

Briefly, our previous work on AAS/Androgen use focused centred on the fact that there are numerous, and well documented, health implications associated with their use (Crisp & Sims 2020a), and that there are a range of emerging problems related to how AAS/Androgen use may compromise immune responses in otherwise healthy individuals, a particular worry given the nature of COVID-19 (Crisp & Sims 2020b/2021). Indeed, many of these problems are linked to the manner in which COVID-19 can trigger critical disease responses (Maccio et al. 2021; UK Health Security Agency 2021), oftentimes based on hyperinflammatory responses. Overall, because of the potential for increased morbidity for AAS/Androgen users from COVID-19 infection, we posited that AAS/Androgen use should be mitigated for and understood within public health discourse and mandates (Crisp & Sims 2020a/2020b), and

further outlined how the empirical evidence was starting to clearly demonstrate a number of issues related to AAS/Androgen use and COVID-19 (Crisp & Sims 2020b/2021).

Here then, whilst we will revisit these papers in principle, our objective for this commentary/short communication is to refocus our attention on how any increases in AAS/Androgen and image and performance enhancing drugs (IPEDs) use during lockdowns may have occurred, and then ask whether any increased exercise within and post lockdowns might lead to increases in body dysmorphia, drug taking, and more AAS/Androgen use, and ultimately question what impact on health policy this might have. In other words, we seek to update, and extend, our previous work by investigating the emerging themes from lockdown (increased exercise, increased drug use, decreased mental health) that are becoming evident from the popular and fast-response literature.

We start by revisiting some of the more salient points with our 2021 paper (intended to act as a review of recently published articles on androgen supplementation and COVID-19 disease severity), *Public health concerns and increased risk of severe COVID-19 disease through androgen use* (Crisp & Sims 2021). In the context of a variety of public health campaigns and information relative to AAS/Androgen use, one of the more pressing concerns within lockdown was the increased usage of AAS/Androgens and IPEDs in this timeperiod. A key recent influence here, for example, is the work of Dores et al. (2021), who in an international online questionnaire using 3,161 adult participants, found that during COVID-19 lockdowns anxiety issues underpinned by physical appearance significantly increased the probability of using IPEDs. Similar patterns of depressive thoughts and impacts on training frequency and AAS/Androgen consumption during lockdowns are also evident among male strength athletes who recreationally use AAS/Androgens. This was evident in a very recent study by Zoob et al. (2021), again one we highlighted in our 2021 paper, that also demonstrated how lockdown and the lack of AAS/Androgens had some "consequential effects on mental health" (p.1).

While evidence remains limited, it is reasonable to assume that coping behaviours such as problematic social media use, eating disorders, and recreational drug use, given the restrictions and social distancing within lockdowns, may have changed due to less recreational/social opportunities, but also as coping motives for an unprecedented period of social isolation and associated decline in mental health (Robb et al. 2020; Pieh et al. 2021). Indeed, a study of 6,070 participants during May to October 2020, showed that there were changing patterns of substance use, and certainly increased use in terms of coping mechanisms (Benschop et al. 2021). In simple terms then, what is clear is that drug use habits did seem to

be affected during lockdown (Ornell et al. 2020) and have changed somewhat after and that, whilst not specific to recreational AAS/Androgen use, it is highly likely that more people were doing 'drugs' during the pandemic or just after, and crucially, as Benschop et al. (2021:1) clarify, with the subsequent possibility of "prolonged changes in substance use with lingering "post-corona" consequences".

In a similar fashion, considering some of the motivations behind recreational IPEDs and AAS/Androgen users, it is well worth noting that, in a study of 319 health club users, eating disorder symptomology were significantly higher post lockdown (Trott et al. 2021). Moreover, Shibata et al. (2021) found that of those already active more people did exercise during the pandemic lockdowns, and that for this group more of them were excessively exercising, and surmised - given the higher rates of IPEDs use in this group – that monitoring of this may be necessary. Indeed, in a preprint systematic review on the impact of COVID-19 and restrictions related to the pandemic (e.g., social distancing and lockdown) on body image, disordered eating, and eating disorder outcomes, Schneider et al. (2021) found that despite variations between studies, the consensus of findings were that COVID-19 pandemic and lockdown negatively impacted body image and eating disorders symptomology.

Whilst we have previously mentioned the lack of articles centred on peoples' changing AAS/Androgen and IPEDs use during and post lockdowns, this is not necessarily true in terms of how attitudes towards taking them have changed. Indeed, in a study of 127 gym users, Bejtkovský and Snopek (2021) found that there was piqued interest in researching and taking AAS/Androgens during the pandemic and post lockdown. Admittedly a more nuanced, yet distinct, difference between the separation of actual use and the feeling and perceptions that may motivate people to take AAS/Androgens, nevertheless, in terms of public health initiatives and discourse, this is concerning.

Moreover, once this greater interest in taking AAS/Androgens is taken into consideration, evidence alluding to the possibility of an increase in AAS/Androgen use post lockdown due to users, old and potentially new, of exiting lockdowns and having their training 'reinvigorated' by training with others, alongside the opening up of the informal, illegal face to face AAS/Androgen drugs trade (Gibbs 2021), needs to be taken into account. Indeed, given this we believe it is incumbent upon policy makers to quickly identify these emerging themes from lockdown that demonstrate how increased exercise, drug use (recreational and AAS/Androgens), and increased pressure on mental health through rising body dysmorphia and the like. It is only in the way that quick responses can be made, particularly in light of what we have previously outlined as exacerbated health concerns related to COVID-19 for otherwise

healthy AAS/Androgen users (which, as this commentary/short communication has outlined, has increased during and post-lockdown and shows potential for continuing risk), that public health initiatives can be fully informed.

References

1. ANTIA, R. & E. M. HALLORAN, 2021. Transition to endemicity: Understanding COVID-19. In: *Immunity*. **54**(10), 2172-2176. DOI: 10.1016/j.immuni.2021.09.019.
2. BENSCHOP, A., F. VAN BAKKUM & J. NOIJEN, 2021. Changing Patterns of Substance Use During the Coronavirus Pandemic: Self-Reported Use of Tobacco, Alcohol, Cannabis, and Other Drugs. In: *Frontiers in Psychiatry*. **12**(633551). DOI: 10.3389/fpsyt.2021.633551.
3. BEJTKOVSKÝ, J. & P. SNOPEK, 2021.Impact of the COVID-19 Pandemic on Behaviour and Preference Changes in Relation to Selected Anabolic Androgenic Substances and Steroids: A Research Study. In: *ADIKTOLOGIE*. **21**: 95-103. DOI: 10.35198/01-2021-002-0002.
4. CRISP, P. & J. SIMS, 2020a. Towards A Natural for Life Movement in Sport: Health Implications, Cheating, And Why Anabolic Steroid Users Should Be Banned for Life. In: *Biomedical Journal of Scientific & Technical Research.* **24**(4), 18368-18370. DOI: 10.26717/BJSTR.2020.24.004070.
5. CRISP, P. & J. SIMS, 2020b. COVID-19 and anabolic-androgenic steroids (AAS) as immunosuppresors: is it time to revisit government policy and governance arrangements on AAS? In: *Archives of Sports Medicine.* **4**:245–246. DOI: 10.36959/987/260.
6. CRISP, P. & J. SIMS, 2021. Public health concerns and increased risk of severe COVID-19 disease through androgen use. In: *Current Opinion in Endocrinology, Diabetes and Obesity.* **28**(5), 625-629. DOI: 10.1097/MED.0000000000000674.
7. DORES, A. R., I. P. CARVALHO., J. BURKAUSKAS et al. 2021. Exercise and use of enhancement drugs at the time of the COVID-19 pandemic: a multicultural study on coping strategies during self-isolation and related risks. In: *Frontiers in Psychiatry.* **12(**648501): DOI: 10.3389/fpsyt.2021.648501.
8. GIBBS, N., 2021.No one's going to buy steroids for a home workout': the impact of the national lockdown on hardcore gym users, anabolic steroid consumption and the image and performance enhancing drugs market. In: *Journal of Contemporary Crime, Harm, and Ethics.* **1**(1): 45-62. DOI: 10.0118/jcche.v1i1.1120.

9. JOINT COMMITTEE ON VACCINATION AND IMMUNISATION [JCVI]. JCVI advice on the UK vaccine response to the Omicron variant, 2021. Accessible from: https://www.gov.uk/government/publications/uk-vaccine-response-to-the-omicron-variant-jcvi-advice/jcvi-advice-on-the-uk-vaccine-response-to-the-omicron-variant.
10. MACCIO, A., S. OPPI & C. MADEDDU, 2021. COVID-19 and cytokine storm syndrome: can what we know about interleukin-6 in ovarian cancer be applied? In: *Journal of Ovarian Research.* **14**(28): DOI: 10.1186/s13048-021-00772-6.
11. NATIONAL HEALTH SERVICE (NHS) Who is at high risk from coronavirus (COVID-19), 2021. Accessible from: https://www.nhs.uk/conditions/coronavirus-covid-19/people-at-higher-risk/who-is-at-high-risk-from-coronavirus/.
12. ORNELL, F., H. F. MOURA., J. N. SCHERER et al., 2020. The COVID-19 pandemic and its impact on substance use: Implications for prevention and treatment. In: *Psychiatry Research.* **289**(113096). DOI: 10.1016/j.psychres.2020.113096.
13. PIEH, C., S. BUDIMIER., J. DELGADILLO et al., 2021. Mental Health During COVID-19 Lockdown in the United Kingdom. In: *Psychosomatic Medicine.* **83**(4), 328-337. DOI: 10.1097/PSY.0000000000000871.
14. UK HEALTH SECURITY AGENCY, 2021. Guidance: COVID-19: epidemiology, virology, and clinical features. Accessible from: https://www.gov.uk/government/publications/wuhan-novel-coronavirus-background-information/wuhan-novel-coronavirus-epidemiology-virology-and-clinical-features#:_:text=Coronaviruses%20are%20a%20large%20family,such%20atext=Coronaviruses%20are%20a%20large%20family,such%20as%20-the%20common%20cold.
15. ROBB, C. E., C. A. DE JAGER & S. AHMADI-ABHARI, 2020. Associations of Social Isolation with Anxiety and Depression During the Early COVID-19 Pandemic: A Survey of Older Adults in London, UK. In: *Frontiers in Psychiatry*. **11**(591120). DOI: 10.3389/fpsyt.2020.591120.
16. SCHNEIDER, J., G. PEGRAM., B. GIBSON. et al. 2021. A Mixed-Studies Systematic Review on the Impact of COVID-19 on Body Image, Disordered Eating, and Eating Disorders. In: *PsyArXiv Preprints.* DOI: 10.31234/osf.io/w7xfg.
17. SHIBATA, M., J. BURKAUSKAS., A. R. DORES et al., 2021. Exploring the Relationship Between Mental Well-Being, Exercise Routines, and the Intake of Image and Performance Enhancing Drugs During the Coronavirus Disease 2019 Pandemic: A Comparison Across Sport Disciplines. In: *Frontiers in Psychology*. **12**(689058). DOI: 10.3389/fpsyg.2021.689058.

18. TROTT, N., J. JOHNSTONE., S. PARDHAN et al., 2021. Changes in body dysmorphic disorder, eating disorder, and exercise addiction symptomology during the COVID-19 pandemic: A longitudinal study of 319 health club users. *Psychiatry Research.* **298**(113831). DOI: 10.1016/j.psychres.2021.113831.
19. ZOOB CARTER, B. N., I. D. BOARDLEY & K. VAN de VEN, 2021. The impact of the COVID-19 pandemic on male strength athletes who use nonprescribed anabolic-androgenic steroids. In: *Frontiers in Psychiatry*. **12**(636706). DOI: 10.3389/fpsyt.2021.636706.

DOI 10.2478/afepuc-2022-0002
© Acta Facultatis Educationis Physicae Universitatis Comenianae 2022, 62(1): 8-15

EXPLOSIVE POWER OF LOWER LIMBS OF ACROBATIC ROCK AND ROLL DANCERS

Adéla Chlapcová[1], Peter Olej[1], Kateřina Kolbová[2], Oľga Kyselovičová[1]

[1]Comenius University in Bratislava, Faculty of Physical Education and Sport, Department of Gymnastics, Dance, Fitness and Martial Arts, Slovakia

[2]Charles University in Prague, Faculty of Physical Education and Sport, Department of Gymnastics, Czech Republic

Summary: Acrobatic rock and roll is dynamic sport dance where explosive power is very important ability. **Aim.** The aim of the thesis was to determine and compare the level of explosive power of the lower limbs of acrobatic rock and roll dancers. We assume that dancers from couple categories will reach a significantly higher level of explosive power of the lower limbs than dancers from ladies formations. **Methods.** The research sample consisted of 22 acrobatic rock and roll female dancers. To determine the level of explosive power of the lower limbs, we used a 10 s test on a jump ergometer. We used the non-parametric statistical method Mann Whitney U-test for independent files. **Results**. The female dancers from couple categories achieved better results in all parameters than dancers from ladies formations. The first examined parameter was the power in the active phase of the take off where the dancers from couples achieved 46.08 ± 5.32 $W.kg^{-1}$, the dancers from ladies formations reached 38.13 ± 3.63 $W.kg^{-1}$ ($p \leq 0.01$, $r = 0.64$). The second examined parameter was the height of the jump, where dancers from couples achieved 28.91 ± 2.49 cm, dancers from ladies formations reached 25.92 ± 3.21 cm ($p \leq 0.05$, $r = 0.48$). The last examined parameter was the rebound efficiency, where dancers from couples achieved 177.41 ± 25.62 $cm.s^{-1}$, dancers from ladies formations reached 138.48 ± 15.96 $cm.s^{-1}$ ($p \leq 0.01$, $r = 0.65$). **Conclusions.** In addition to differences in the explosive power of the lower limbs, the results also pointed to the importance of development in all categories. We recommend dancers to include plyometric exercises and repeated rope skipping jumps in the pre-competition and competition period, after completing strength training.

Key words: acrobatic rock and roll, explosive power of lower limbs, jump ergometer.

Introduction

Acrobatic rock and roll is a dynamic sport dance that combines dance with acrobatics, and its sport performance consists of dance choreography (foot technique) and acrobatic

choreography (Olej 1997; 2005). Based on the structure of sports performance, we focus on the explosive power of the lower limbs, which according to Řezníčková (2010), Vasilčák (2014) and Chlapcová (2019) are among the limiting factors of sports performance in acrobatic rock and roll in all categories. Many authors have tested the explosive power of lower limbs through jump ergometer tests such as Zemková, Dzurenková and Pelikán (2001) or Nitzsche, Stutzig, Walter and Siebert (2015). We characterize an explosive power as the ability to develop maximum force in the shortest possible time. It manifests itself especially during bounce, which purpose is to throw the body to the required height (Šimonek, Doležalová and Lednický 2007). The explosive power is characterized by the ballistic character of the muscle activity, which is completed by the flight phase of the center of gravity of athlete's body or equipment (Vanderka 2016). Acrobatic rock and roll belong to anaerobic-aerobic sports. The sports performance in girls formations lasts in the preliminary rounds from 1:30 to 1:45 min and in the semifinals and finals from 2:15 to 2:30 min. In couple categories, the length of sports performance is in foot technique from 1:00 to 1:15 min and in acrobatic performance from 1:45 to 2:00 min. The aim of the work was to determine and compare the level of explosive power of the lower limbs of acrobatic rock and roll dancers. We wanted to point out to the different level of explosive power of the lower limbs due to the different structure of sports performance in each category. We assume that dancers from the couple categories will reach a significantly higher level of explosive power of the lower limbs than dancers of girls' formations.

Methods

Participants

The research sample consisted of 22 acrobatic rock and roll dancers which were members of the Czech club KOLBDANCE VSK FTVS Praha. The first group (n = 10) were dancers of couple categories with a mean decimal age of 20.27 ± 3.60 years. Each dancer danced in the couple category for at least 3 years in the main age category (Couple dance show, Main class contact style and Main class free style). Somatic indicators of dancers from couple category are in table 1.

Table 1

Somatic indicators of dancers from couple category

Couple category (n = 10)				
	Decimal age (years)	Sport age (years)	Body height [cm]	Body weight [kg]
$\bar{x}$	20.27	11.40	165.00	57.40
s	3.60	2.87	5.29	5.00
Me	19.52	11.00	165.00	57.00
x_{min}	15.25	6.00	159.00	50.00
x_{max}	28.96	16.00	175.00	65.00

The second group (n = 12) were ladies formation dancers with a mean decimal age of 18.08 ± 3.78 years. Their somatic indicators are in table 2.

Table 2

Somatic indicators of dancers from the ladies formation

Ladies formation (n = 12)				
	Decimal age (years)	Sport age (years)	Body height [cm]	Body weight [kg]
$\bar{x}$	18.08	10.25	166.00	58.75
s	3.78	4.23	5.52	9.44
Me	16.35	9.00	166.00	55.00
x_{min}	14.70	5.00	158.00	47.00
x_{max}	25.95	16.00	173.00	77.00

Procedures

The research sample was tested during the summer training camp. We used a 10 s test on a jump ergometer (FiTRO Jumper) to determine the level of explosive power of the lower limbs. Dancers performed repeated jumps for 10 seconds with maximum frequency and intensity. Each dancer repeated the test 2 times to achieve the best possible performance and had a 2 minute rest between tests. During the test probands had to have their hands fixed on their hips. All dancers were tested barefoot. To achieve maximum performance, they tried to bounce with the greatest force as quickly as possible. We decided to monitor and compare the following indicators: power in the active phase of the take off (P), height of the jump (h) and a parameter called rebound efficiency (h/tc), or the ability to bounce as intensively as possible in the shortest possible time. From the selected parameters, we recorded the 3 best values and calculated the arithmetic mean (Tkáč et al. 1990).

Statistical analysis

We used basic matematical-statistical characteristics such as mean ($\bar{x}$), standard deviation (s), median (Me), maximum value (x_{max}) and minimum value (x_{min}). We used the nonparametric Mann-Whitney U test and we set the level of significance at $p \leq 0.05$ and $p \leq 0.01$. To determined the effect size we used Cohen's r.

Results

The first parameter was the power in the active phase of the take off. The mean values of dancers from couple category and from ladies formation can be seen in Figure 1. Dancers from couples achieved a better average result, namely 46.08 ± 5.32 $W.kg^{-1}$, dancers from ladies formations achieved 38.13 ± 3.63 $W.kg^{-1}$. The difference between the dancers was 7.95 $W.kg^{-1}$, which is 17.25 %. This difference is statistically significant (p = 0.0027) according to the Mann-Whitney U test (U = 14). Cohen's r represented a value of r = 0.64, which means great material significance.

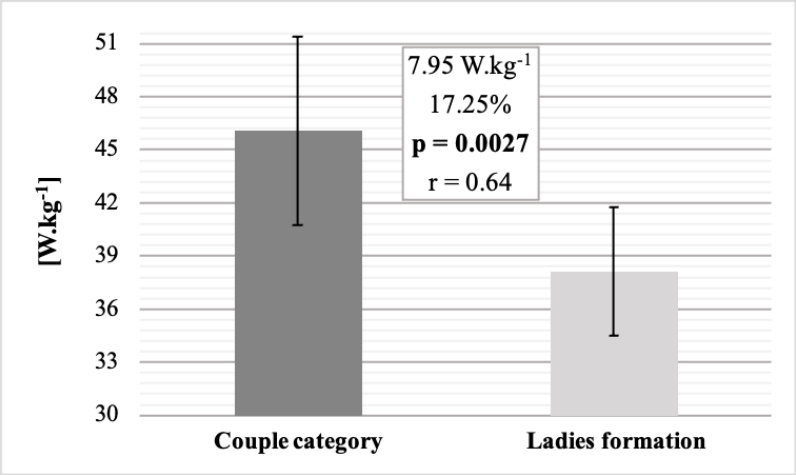


Figure 1
Jump ergometer - power in the active phase of the take off

The second parameter was the height of the jump. The average values of the dancers can be seen in Figure 2. Dancers from the couples achieved a better average result (28.91 ± 2.49 cm) than dancers from the ladies formations (25.92 ± 3.21 cm). The difference between the dancers was 2.99 cm, which is 10.34%. This difference is statistically significant (p = 0.0021) according to the Mann-Whitney U test (U = 25.5). Cohen's r represented a value of r = 0.48, which means medium materiality.

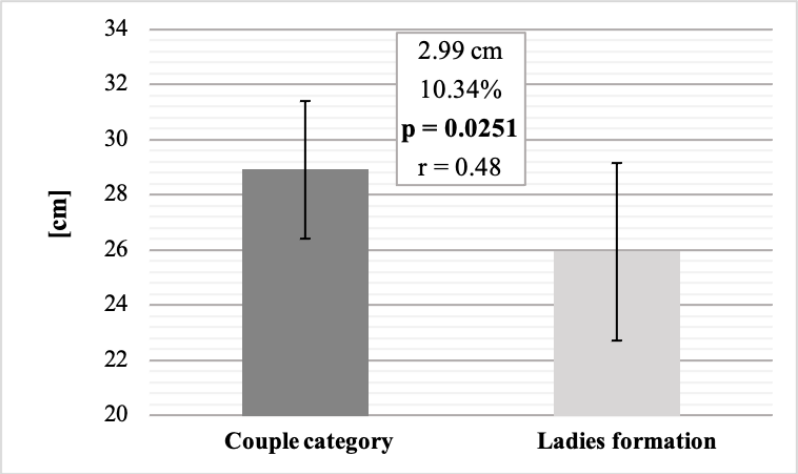


Figure 2
Jump ergometer - height of the jump

The last parameter was the rebound efficiency. The average values of dancers from couples and from the ladies formation can be seen in Figure 3. Dancers from couples achieved a better average result, namely 177.41 ± 25.62 $cm.s^{-1}$, dancers from ladies formations achieved 138.48 ± 15.96 $cm.s^{-1}$. The difference between the dancers was 38.93 $cm.s^{-1}$, which is 21.94%. The difference between couples and formations dancers is statistically significant (p = 0.0251) according to the Mann-Whitney U test (U = 13). Cohen's r represented a value of r = 0.65, which means great material significance.

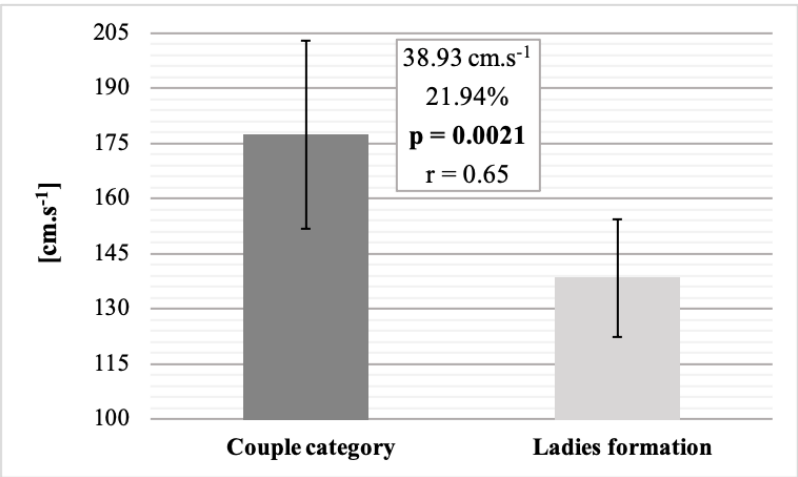


Figure 3
Jump ergometer - rebound efficiency

Discussion

Zemková and Hamar (2004) examined acrobatic rock and roll dancers with jump ergometer test and they focus on power in the active phase of the take off. They mention that

female dancers have better jump abilities from straight legs than male dancers, which can be attributed to genetic disposition as a higher share of fast muscle fibers or the fact that female sport performance is more similar to the test structure. Male dancers perform more elements from squat position. In our study we focus only on female dancers and due to the difference in couples and formations sport performance, we can say that the better results of couple dancers are caused by the acrobatic part of sport performance and gymnastic preparation.

Dzurenková (1999) presents a comparison between acrobatic rock and roll dancers of the category Main class free style (51.8 $W.kg^{-1}$) and the general population (36 $W.kg^{-1}$). We assume that the lower values in our ensemble are caused by a larger number of dancers from category Main class contact style and Couple dance show.

Macík (2014) analysed changes in motor skills in two top couples. During the experimental 6-week mesocycle in the preparation period, he performed 6 measurements on a jump ergometer. The female dancer from category Main class contact style reached an average jump height of 32.97 ± 1.35 cm and the female dancer from category Main class free style category reached 31.90 ± 2.29 cm. The largest changes during the 6-week program were recorded on Main class free style dancer (5 cm, 17.42 %).

Limitation of the study

In this study we had the opportunity to test only a few dancers from the Main class free style category.

Conclusions

Based on the results, we confirmed that dancers from couple categories achieved a significantly higher level of explosive power of the lower limbs than dancers from ladies formations. In power in the active phase of the take off and rebound efficiency at $p \leq 0.01$ and in the height of jumps at $p \leq 0.05$. In addition to differences in the explosive power of the lower limbs, the results also highlighted the importance of development in all categories.

Acknowledgement

The study was supported by the project of Ministry of Education, science and research of Slovak Republic VEGA 1/0754/20.

References

1. DZURENKOVÁ, D., E. ZEMKOVÁ, T. MARČEK, M. HÁJKOVÁ & H. PELIKÁN, 1999. Vyšetrenia anaeróbnych a aeróbnych schopností v rockenrolle. In: *Zborník z medzinárodnej konferencie Pohyb a zdraví*. Olomouc: Fakulta tělesné kultúry UP.
2. CHLAPCOVÁ, A., 2019. *Úroveň vybraných pohybových schopností 8- až 10- ročných tanečníčok akrobatického rokenrolu.* Bratislava. Bakalárska práca. Univerzita Komenského v Bratislave, Fakulta telesnej výchovy a športu. Katedra atletiky.
3. MACÍK, M., 2014. *Zmeny úrovne vybraných pohybových schopností vrcholových rock and rollistov v prípravnom mezocykle.* Bratislava. Bakalárska práca. Univerzita Komenského v Bratislave, Fakulta telesnej výchovy a športu, Katedra atletiky.
4. NITZSCHE, N., N. STUTZIG, A. WALTHER & T. SIEBERT, 2015. Effects of PlyometricTraining on Rock'n'Roll Performance. In: *International Journal of Kinesiology and Sports Science* [online]. **3(**4), 8-15. [cit. 2022-02-21]. Accessible from: https://www.researchgate.net/publication/282642115_Effects_of_Plyometric_Training_on_Rock'n'Roll_Performance.
5. OLEJ, P., 1997. *Objektivizácia výkonnosti v akrobatickom rock and rolle.* Bratislava. Diplomová práca. Univerzita Komenského v Bratislave, Fakulta telesnej výchovy a športu, Katedra gymnastiky, tancov a úpolov.
6. OLEJ, P., 2005. *Objektivizácia motorického učenia akrobatických cvičebných tvarov v akrobatickom rock and rolle.* Bratislava. Dizertačná práca. Univerzita Komenského v Bratislave, Fakulta telesnej výchovy a športu, Katedra gymnastiky, tancov a úpolov.
7. ŘEZNÍČKOVÁ, L., 2010. *Metodika nácviku akrobatických cvičebných tvarov v akrobatickom rock and rolle v kategórií dievčenské formácie senior.* Bratislava. Bakalárska práca. Univerzita Komenského v Bratislave, Fakulta telesnej výchovy a športu, Katedra gymnastiky.
8. VASILČÁK, T., 2014. *Úroveň výbušnej sily rokenrolistov*. Bratislava. Bakalárska práca. Univerzita Komenského v Bratislave, Fakulta telesnej výchovy a športu, Katedra gymnastiky.
9. ŠIMONEK, J., L. DOLEŽAJOVÁ & A. LEDNICKÝ, 2007. *Rozvoj výbušnej sily dolných končatín v športe.* Vydavateľstvo: Slovenská vedecká spoločnosť pre telesnú výchovu a šport. Bratislava. ISBN 978- 80-89075-32-4.
10. TKÁČ, M., D. HAMAR, Ľ. KOMADEL & O. KUTHANOVÁ, 1990. *Measurement of anaerobic power of the lower limbs by the method of repeated jumps*. In: ZEMKOVÁ, E.

& D. HAMAR. 2004. Jump ergometer in sport performance testing. In: *Acta Univ. Palacki. Olomuc., Gymnica.* **35**(1). ISSN 1213-8312.

11. VANDERKA, M., 2016. *Silový tréning.* Bratislava: Univerzita Komenského, 2016. ISBN 978- 80-89075-54-6.
12. ZEMKOVÁ, E. & D. HAMAR, 2004. Jump ergometer in sport performance testing. In: *Acta Univ. Palacki. Olomuc., Gymnica.* **35**(1). ISSN 1213-8312.
13. ZEMKOVÁ, E., D. DZURENKOVÁ & H. PELIKÁN, 2001. Assessment of jump abilities in rock'n'roll performers. In: *Homeostasis in Health and Disease.* **41**(6), 265-267.

DOI 10.2478/afepuc-2022-0003
© Acta Facultatis Educationis Physicae Universitatis Comenianae 2022, 62(1): 16-25

SELF-PERCEIVED FATIGUE AFTER MOTOR ABILITIES TESTING IN ADOLESCENT ELITE TENNIS PLAYERS

Juraj Nemček[1], Dagmar Nemček[2]

[1] *Comenius University in Bratislava, Faculty of Physical Education and Sports, Department of Sports Games, Slovakia*

[2] *Comenius University in Bratislava, Faculty of Physical Education and Sports, Department of Sports Sciences in Educology and Humanities, Slovakia*

Summary: The objective of the study was to determine self-perceived fatigue (S-PF) after motor abilities testing (MAT) in adolescent male and female elite tennis players. The research sample comprised of 17 male (mean age of 13.00 ± 1.54 years) and 20 female (mean age of 13.15 ± 1.42 years) adolescent elite tennis players who underwent testing of selected motor abilities in tennis. The level of fatigue in adolescent elite tennis players was measured with the Training Distress Scale (TDS). Both groups of elite tennis players declared the lowest, zero level of S-PF by TDS symptoms as inability to remember things and loose bowels or diarrhoea and significant S-PF during 48 hours after MAT was in both genders felt by lack of energy, feeling of heavy arms and legs, joint stiffness of soreness, and muscle soreness. Boys versus girls experienced significantly higher S-PF in the symptoms as difficulty falling asleep, being unusually tired during the day, joint stiffness of soreness, and ordinary tasks require extra effort. No significant differences were found in overall TDS between males and females adolescent elite tennis players.

Key words: elite tennis players, boys, girls, fatigue, Training Distress Scale, symptoms

Introduction

Several different definitions of fatigue exist, often dependent upon the experimental model employed and/or the conditions under which they occur. Fatigue is a complex and multifaceted phenomenon that has a variety of possible mechanisms (Halson 2014; Bendíková 2017). One of the most common definitions of fatigue was proposed by Edwards (1983) and states that fatigue is a "failure to maintain the required or expected force (or power output)." Fatigue can also be influenced by the type of stimulus (voluntary or electrical), type of

contraction (isometric, isotonic, and intermittent or continual), duration, frequency and intensity of exercise, and type of muscle (Sahlin 1992).

As athletes strive to improve their performance, modifications in training load are required, particularly increases in frequency, duration, and intensity. Training loads are adjusted at various times during the training cycle to either increase or decrease fatigue depending on the phase of training (i.e., baseline or competition phase). Ensuring that fatigue is titrated appropriately is important for both adaptations to training as well as for competition performance (Pyne & Martin 2011). Elite athletes believe mental fatigue negatively impacts sporting performance. Analysis of Russell et al. (2019) revealed perceived associations between mental fatigue and changes in behaviour including, disengagement, decreased motivation and enthusiasm, increased displays of emotion and withdrawal. Changes in concentration, decreased discipline and attention to detail also emerged as descriptors of mental fatigue. Media engagements, study and work commitments were reported to induce mental fatigue (Russell et al. 2019).

The physiological and training status of the elite athlete and the environmental conditions may also significantly influence fatigue. The definitions and caveats mentioned above highlight both the multi-factorial nature of fatigue and the inherent complexities of trying to monitor or measure fatigue in the athlete. For the purpose of this short review, and to reflect a practical perspective, fatigue is defined as "an inability to complete a task that was once achievable within a recent time frame" (Pyne & Martin 2011). Study of Sargent et al. (2014) declares that shorter sleep durations in elite athletes are associated with higher levels of pre-training fatigue. Findings suggest that the amount of sleep an elite athlete obtains is dictated by their training schedule. In particular, early morning starts reducing sleep duration and increase pre-training fatigue levels.

More generically, fatigue is considered the exercise-induced reduction in the force generating capacity of muscle (Gandevia 2001) wherein its manifestations in tennis are presumed to vary. High-intensity, intermittent, skill-based nature of the sport partly challenges definitive classifications of fatigue in tennis. That is, where definitions of fatigue in some field sports reference a reduction of peak speed or power output between multiple efforts (Duffield, Coutts & Quinn 2009; Coutts et al. 2010), the activity profile of tennis does not easily conform to such definitions. Indeed, whether fatigue in tennis manifests in changes to locomotion, technical proficiency or cognitive performance is unclear (Reid & Duffield 2014). Hyperthermia, dehydration and hypoglycaemia have all been identified as common challenges

to sustained performance proficiency in tennis, with emerging evidence suggesting central fatigue may also be a key stressor (Horney et al. 2007).

The objective of the study was to determine self-perceived fatigue during 48 hours after motor abilities testing in adolescent male and female elite tennis players.

Material and methods

Participants

The research sample comprised a total of 37 adolescent elite tennis players. 17 boys (mean age of 13.00 ± 1.54 years) and 20 girls (mean age of 13.15 ± 1.42 years) participated in the questionnaire survey. All tennis players are included in the system support of the Slovak Tennis Association with a ranking up to 10th place in the Slovak national ranking. In this study, informed consent was obtained from all participants. The research was approved by the Ethics Committee of the Faculty of Physical Education and Sports, Comenius University in Bratislava, Slovakia (No. 10/2019).

Research design

Adolescent elite tennis players underwent testing of selected motor abilities in tennis over the course of one day. They completed the following tests: (1) Bend and reach test, (2) Standing long jump test, (3) Pick up tennis balls test (fan), (4) 20-m sprint test (with 5 and 10 m split times), (5) 2 kg medicine ball throw test, (6) Serve speed and accuracy test, (7) Hit and turn tennis-specific endurance test (Ferrauti, Ulbricht & Pfannkoch 2013). For 48 hours after motor abilities testing (MAT), they were asked to observe symptoms of fatigue on themselves (S-PF; self-perceived fatigue). After 48 hours, they completed a questionnaire where they mediated the level of fatigue symptoms experienced.

The level of fatigue in adolescent elite tennis players was measured with the Training Distress Scale (TDS; Grove et al. 2014), a 19-item measure assessing the distress symptoms previously identified by Fry et al. (1994). These symptoms include a variety of complaints related to emotionality, general fatigue, concentration difficulties, physical discomfort, sleep disturbance, and appetite changes. Example items are “lack of energy,” “quick tempered,” “unable to maintain attention,” “muscle soreness,” “trouble falling asleep,” and “loss of appetite.” Adolescent elite tennis players responded to these items by indicating the extent to which they had experienced each of the symptoms during the past 48 h. All responses were made on a 5-point bipolar scale anchored by the phrases not at all (0) and extreme amount (4).

A higher mean point score meant higher experience of TDS symptom as well as higher levels of self-reported fatigue.

Statistical analysis

The program IBM SPSS Statistics version 23.0 was used for data processing. The data were described using absolute and relative frequencies, including the mean ($\overline{x}$) and standard deviation (±SD). The Non-parametric Mann-Whitney U-test was used to assess differences in S-PF between two independent samples according to gender (boys versus girls). Wilcoxon Signed Rank Test was used to assess the differences between two related samples – TDS symptoms inside boys' and girls' groups. The significance level was set at $\alpha \leq 0.05$ (*) and $\alpha \leq 0.01$ (**). The rate of dependence (effect size) between the two samples of features was conveyed by means of the coefficient *r* ($r > 0.90$ - very large effect size, $r = 0.70 – 0.90$ - large effect size, $r = 0.50$-0.70 - medium effect size, $r = 0.30 – 0.50$ - small effect size, $r < 0.29$ – very small effect size) proposed by Pett (1997). In the current study, only one measurement has been made and two main groups of adolescent elite tennis players according to the gender formed the study.

Results

In the group of male elite tennis players, absolutely no S-PF during 48 hours after MAT was manifested by TDS symptoms such as not being able to remember things, loss of appetite, not being able to eat well, and mental confusion, as these symptoms scored 0.000 points of the mean score (Table 1).

Table 1

Differences in TDS symptoms between boys' and girls' elite tennis players

TDS symptoms	Boys (n = 17)	Girls (n = 20)	Mann-Whitney U-Test		
	$\bar{x}$/ ± SD		*U*	*p*	*abs (r)*
Muscle soreness	1.294 ± 1.104	0.850 ± 0.988	128	0.182	0.207
Lack of energy	0.294 ± 0.469	0.350 ± 0.670	167	0.922	0.048
A quick temper	0.117 ± 0.485	0.100 ± 0.447	168	0.907	0.018
Not being able to remember things	0.000 ± 0.000	0.000 ± 0.000	170	1.000	----
Difficulty falling asleep	0.176 ± 0.392	0.000 ± 0.000	140*	0.050	0.302
Loss of appetite	0.000 ± 0.000	0.150 ± 0.489	153	0.186	0.212
Lack of interest in normal daily activities	0.294 ± 0.469	0.150 ± 0.366	145	0.295	0.168
Snappiness with family or teammates	0.058 ± 0.242	0.000 ± 0.000	160	0.278	0.167
Not being able to focus	0.117 ± 0.332	0.050 ± 0.223	158	0.459	0.117
Heavy feelings in your arms or legs	0.471 ± 0.717	0.500 ± 0.607	159	0.713	0.022
Restless sleep	0.058 ± 0.242	0.000 ± 0.000	160	0.278	0.167
Not being able to eat well	0.000 ± 0.000	0.100 ± 0.447	161	0.357	0.156
Being unusually tired during the day	0.588 ± 0.712	0.150 ± 0.366	112*	0.028	0.361
General irritability	0.235 ± 0.562	0.100 ± 0.308	156	0.472	0.147
Mental confusion	0.000 ± 0.000	0.100 ± 0.308	153	0.186	0.224
Joint stiffness of soreness	0.588 ± 0.712	0.200 ± 0.410	120*	0.049	0.316
Loose bowels or diarrhoea	0.000 ± 0.000	0.000 ± 0.000	170	1.000	----
Insomnia	0.058 ± 0.242	0.000 ± 0.000	160	0.278	0.167
Ordinary tasks require extra effort	0.353 ± 0.492	0.100 ± 0.308	121*	0.049	0.294
Overall TDS	**0.248 ± 0.231**	**0.153 ± 0.132**	**320**	**0.318**	**0.245**

Note. *U* = Mann-Whitney U-test statistics; *p* = statistical significance (*p*-values *≤.05, **≤.01); abs(r) = absolute value of *r* = effect size

Table 2

The level of S-PF in adolescent elite tennis players

Without S-PF symptoms		With S-PF symptoms	
Boys	**Girls**	**Boys**	**Girls**
Not being able to remember things	Not being able to remember things	Lack of energy	Joint stiffness of soreness
Loss of appetite	Difficulty falling asleep	Lack of interest in normal daily activities	Lack of energy
Not being able to eat well	Snappiness with family or teammates	Ordinary tasks require extra effort	Heavy feelings in your arms or legs
Mental confusion	Restless sleep	Heavy feelings in your arms or legs	Muscle soreness
Loose bowels or diarrhoea	Loose bowels or diarrhoea	Being unusually tired during the day	
Snappiness with family or teammates	Insomnia	Joint stiffness of soreness	
Restless sleep	Not being able to focus	Muscle soreness	
Insomnia	A quick temper		
A quick temper	Not being able to eat well		
Not being able to focus	General irritability		
Difficulty falling asleep	Mental confusion		
General irritability	Ordinary tasks require extra effort		
	Loss of appetite		
	Lack of interest in normal daily activities		
	Being unusually tired during the day		

Note. Wilcoxon Signed Rank Test was used to assess the differences between two related samples – TDS symptoms, inside boys' and girls' groups.

Along with these TDS symptoms, male elite tennis players did not show S-PF during 48 hours after MAT in following symptoms: loose bowels or diarrhoea, snappiness with family or teammates, restless sleep, insomnia, a quick temper, not being able to focus and maintain attention, difficulty falling asleep, general irritability (total 63.2 % of TDS symptoms). On the other hand, significant S-PF during 48 hours after MAT was in male elite tennis players felt by lack of energy, lack of interest in normal daily activities, extra effort in carrying out ordinary tasks, feeling of heavy arms and legs, unusual tiredness during the day, joint stiffness of soreness, and muscle soreness (Table 2).

In the group of female elite tennis players, absolutely no S-PF during 48 hours after MAT was manifested by TDS symptoms such as not being able to remember things, difficulty falling asleep, snappiness with family or teammates, restless sleep, loose bowels or diarrhoea, and insomnia as these symptoms scored 0.000 points of the mean score (Table 1). Along with these TDS symptoms, female elite tennis players did not show S-PF during 48 hours after MAT in symptoms listed in Table 2 (total 78.9 % of TDS symptoms). On the other hand, significant S-PF during 48 hours after MAT was in female elite tennis players felt by joint stiffness of soreness, lack of energy, feeling of heavy arms and legs and muscle soreness (Table 2).

Furthermore, we found that girls (21.1 %), compared to boys (36.8 %), experienced S-PF to a lesser extent after MAT, as they declared the fatigue in fewer TDS symptoms (Table 2). Together, boys and girls elite tennis players did not experience S-PF within 48 hours after MAT in the following twelve symptoms out of nineteen (63.1 %): not being able to remember things, loss of appetite, not being able to eat well, and mental confusion loose bowels or diarrhoea, snappiness with family or teammates, restless sleep, insomnia, a quick temper, not being able to focus and maintain attention, difficulty falling asleep, general irritability (Table 2). Interestingly, it was found that both groups of elite tennis players declared the lowest, zero level of S-PF by inability to remember things and loose bowels or diarrhoea, and on the other hand, the highest level of S-PF was declared by both groups of elite tennis players by the symptom of muscle soreness (Table 1).

Comparing differences in S-PF during 48 hours after MAT, we found significant differences between boys and girls elite tennis players in four TDS symptoms. Boys versus girls experienced significantly higher S-PF in the symptoms “difficulty falling asleep” ($U = 140$, $p = 0.050$, $r = 0.302$), “being unusually tired during the day” ($U = 112$, $p = 0.028$, $r = 0.361$), “joint stiffness of soreness” ($U = 120$, $p = 0.049$, $r = 0.316$), and “ordinary tasks require extra effort” ($U = 121$, $p = 0.049$, $r = 0.294$). No significant differences in overall TDS between male and female adolescent elite tennis players were found (Table 1).

Discussion

The objective of the present study was to determine self-perceived fatigue during 48 hours after motor abilities testing in adolescent male and female elite tennis players. The present study show, that male elite tennis players did not show S-PF during 48 hours after MAT in 63.2 % of TDS symptoms, and female tennis players in 78.9 % of TDS symptoms. On the other hand, significant S-PF during 48 hours after MAT was in both genders felt by lack of energy, feeling of heavy arms and legs, joint stiffness of soreness, and muscle soreness. Elite athletes in general, show TDS symptoms like "difficulty concentrating" and "fatigue or lack of energy" as an increased risk of poor athletic performance (Takeda et al. 2015). Repetitive exercises involving eccentric actions of high intensity or duration, which adolescent elite tennis players have undergone to test their level of motor abilities, can lead to muscle damage (Byrne et al. 2004). Exercise induced muscle damage is associated with a protective inflammatory response (Peake et al. 2005) and changes in the afferent inputs from the muscle spindle, Golgi tendon organ and groups III and IV afferent nerve endings (Komi 2000). A painful sensation when contracting, stretching, or putting pressure onto the exercised muscle (Weerakkody et al. 2001) is experienced within the first 24 h and last for 1 – 3 days after eccentric exercise (Proske et al. 2004), which was also evident in a group of our elite tennis players during the 48 hours after MAT.

In the current study, boys versus girls experienced significantly higher S-PF. It was shown in TDS symptoms as difficulty falling asleep, being unusually tired during the day, joint stiffness of soreness, and ordinary tasks require extra effort. The research of Wolbeek et al. (2006) shows opposite results, when girls are much more fatigued than boys. This gender difference was because of higher scores on the subscale's severity of fatigue, motivation, and concentration. In girls, medication use, higher age, and lower age at menarche were associated with higher levels of fatigue. In boys, fatigue was associated with symptoms of unrefreshing sleep, muscle pain, and memory and concentration problems. In girls, fatigue severity was also related to unrefreshing sleep, muscle pain, and concentration problems. In addition, headaches and tender lymph nodes were significantly related to fatigue scores in girls only (Wolbeek et al. 2006). Another research corresponds with the results of the previous research when female adolescents with self-reported health disorders declared significantly higher occurrence of self-perceived fatigue compared to male peers (Olekšák & Nemček 2021). Related to sport participation, the study of Nemček & Nemček (2021) revealed significant differences in problems with sleep, and unusual fatigue among three samples of elite junior racket sports

players, when elite junior tennis and table tennis players declare significantly higher problems with sleep compared to badminton players and elite junior table tennis players can feel significantly more unusually tired compared to tennis and badminton players.

In the present study no significant differences in overall TDS between male and female adolescent elite tennis players were found. According to level of fatigue in other racket sports, the results of the Nemček & Nemček's (2021) study revealed, that elite junior table tennis players can feel significantly more unusually tired compared to elite tennis and badminton players. It has been reported that high intense training may affect mood states, leading to anxiety, depression, feelings of fatigue and low self-esteem (Fry et al. 1994). In the study of Millet et al. (2005), the relationship between the training loads and perceived fatigue was significant. Linear mixed model analyses of Sargent et al. (2014) study revealed that on nights prior to training days, time spent in bed was significantly shorter, sleep onset and offset times were significantly earlier, and the amount of sleep obtained was significantly less, than on nights prior to rest days. Moreover, there was a significant effect of sleep duration on pre-training fatigue levels. Specifically, the authors found, that shorter sleep duration is associated with higher levels of pre-training fatigue. Taken together, these findings suggest that the amount of sleep an elite athlete obtains is dictated by their training schedule. In particular, early morning starts reducing sleep duration and increase pre-training fatigue levels (Sargent et al. 2014).

Conclusion

By both genders of elite tennis players, self-perceived fatigue during 48 hours after MAT was declared by the symptoms of "lack of energy", join stiffness of soreness", "heavy feelings in arms or legs", and "muscle soreness". In addition, the male elite tennis players also showed S-PF with symptoms of "lack of interest in normal daily activities", "ordinary tasks require extra effort", and "being unusually tired during the day". Boys versus girls experienced significantly higher S-PF in the symptoms "difficulty falling asleep", "being unusually tired during the day", "joint stiffness of soreness", and "ordinary tasks require extra effort". No significant differences in overall TDS between male and female adolescent elite tennis players were found.

Acknowledgments

This scientific research was supported by the grant projects of the Ministry of Education, Science, Research and Sport of the Slovak Republic VEGA No. 1/0754/20.

References

1. BENDÍKOVÁ, E., 2017. *Theory of health, movement and lifestyle of human beings*. Debrecen: University of Debrecen.
2. BYRNE, C., C. TWIST & R. ESTON, 2004. Neuromuscular function after exercise-induced muscle damage: theoretical and applied implications. In: *Sports Medicine.* **34**, pp. 49–69.
3. COUTTS, A. J., J. QUINN, J. HOCKING et al., 2010. Match running performance in elite Australian Rules Football. In: *Journal of Science and Medicine in Sport.* **13**, pp. 543–548.
4. DUFFIELD, R., A. J. COUTTS & J. QUINN, 2009. Core temperature responses and match running performance during intermittent-sprint exercise competition in warm conditions. In: *The Journal of Strength & Conditioning Research.* **23**, pp.1238–44.
5. EDWARDS, R. H. T., 1983. *Biochemical basis of fatigue in exercise performance*. Champaign: Human Kinetics.
6. FERRAUTI, A., A. ULBRICHT & P. PFANNKOCH, 2013. *DTB-Konditionstest. Testmanual*. Bochum: ZeDI - Zentrum für Diagnostik und Intervention, Ruhr-Universität Bochum [online]. [cit: 2022-03-02] Available from: https://www.dtb-tennis.de/content/download/3457/37608/version/1/file/Testmanual-DTB-Konditionstest-2014.pdf
7. FRY, R. W., J. R. GROVE, A. R. MORTON, P. M. ZERONI, S. GAUDIERI & D. KEAST, 1994. Psychological and immunological correlates of acute overtraining. In: *British Journal of Sports Medicine.* **28**, pp. 241-246.
8. GANDEVIA, S. C., 2001. Spinal and supraspinal factors in human muscle fatigue. *Physiological Reviews.* **81**, pp. 1725–89.
9. GROVE, J. R., L. C. MAIN, K. PARTRIDGE, D. J. BISHOP, S. RUSSELL et al., 2014. Training distress and performance readiness: Laboratory and field validation of a brief self-report measure. In: *Scandinavian Journal of Medicine & Science in Sports* [online]. [cit: 2022-02-02] Available from: http://onlinelibrary.wiley.com/doi/10.1111/sms.12214/pdf.
10. HALSON, S. L., 2014. Monitoring training load to understand fatigue in athletes. In: *Sports Medicine.* **44**(Suppl. 2), pp. 139-147.
11. HORNEY, D. J., D. FARROW, I. MUJIKA & W. YOUNG, 2007. Fatigue in Tennis. In: *Sports Medicine.* **37,** pp. 199–212.
12. KOMI, P. V., 2000. Stretch-shortening cycle: a powerful model to study normal and fatigued muscle. In: *Journal of Biomechanics.* **33**, pp. 1197–1206.

13. MILLET, G. P., A. GROSLAMBERT, B. BARBIER, J. D. ROUILLON & R. B. CANDAU, 2005. Modelling the relationships between training, anxiety, and fatigue in elite athletes. In: *International Journal of Sports Medicine.* **26**, pp. 492-498.
14. NEMČEK, J. & D. NEMČEK, 2021. Subjective well-being of elite junior racket sports players. In: *The 7th International Conference of the Universitaria Consortium in Physical Education, Sport and Physiotherapy*. *Proceedings of ICU 2021*. Bologna: Editografica.
15. OLEKŠÁK, O. & D. NEMČEK, 2021. Gender differences in subjective well-being of high school students with self-reported health disorders participating in sport leisure activities. In: *Studia Scientifica Facultatis Paedagogicae.* **20**(5), pp. 15-27.
16. PEAKE, J., K. NOSAKA & K. SUZUKI, 2005. Characterization of inflammatory responses to eccentric exercise in humans. In: *Exercise Immunology Review.* 11, pp. 64–85.
17. PETT, M. A., 1997. *Nonparametric statistics for health care research: Statistics for small samples and unusual distributions*. Thousand Oaks, CA: Sage.
18. PROSKE, U., J. E. GREGORY, D. L. MORGAN, P. PERCIVAL, N. S. WEERAKKODY & B. J. CANNY, 2004. Force matching errors following eccentric exercise. In: *Human Movement Science.* **23**, pp. 365-378.
19. PYNE, D. B. & D. T. MARTIN, 2011. Fatigue-Insights from individual and team sports. In: MARINO, F.E., editor. *Regulation of fatigue in exercise*. New York: Nova Science, pp. 177–85.
20. REID, M., & R. DUFFIELD, 2014. The development of fatigue during match-play tennis. In: *British Journal of Sports Medicine.* 48, pp. 7-11.
21. RUSSELL, S., D. JENKINS, RYNNE, S., S. L. HALSON & V. KELLY, 2019. What is mental fatigue in elite sport? Perceptions from athletes and staff. In: *European Journal of Sport Science.* **19**(10), pp. 1367-1376.
22. SAHLIN, K., 1992. Metabolic factors in fatigue. In: *Sports Medicine.* 13, pp. 99-107.
23. SARGENT, CH., M. LASTELLA, S. L. HALSON & G. D. ROACH, 2014. The impact of training schedules on the sleep and fatigue of elite athletes. In: *Chronobiology International.* **31,** pp. 1160-1168.
24. TAKEDA, T., Y. IMOTO, H. NAGASAWA, M. MUROYA & M. SHIINA, 2015. Premenstrual syndrome and premenstrual dysphoric disorder in Japanese collegiate athletes. In: *Journal of Pediatric and Adolescent Gynecology*. **28**(4), pp. 215-218.
25. WEERAKKODY, N. S., N. P. WHITEHEAD, B. J. CANNY, J. E. GREGORY & U. PROSKE, 2001. Large-fiber mechanoreceptors contribute to muscle soreness after eccentric exercise. In: *The Journal of Pain.* 2, pp. 209-219.

26. WOLBEEK, M., L. J. P. van DOORNEN, A. KAVELAARS & C. J. HEIJNEN, 2006. Severe fatigue in adolescents: A common phenomenon? In: *Pediatrics*. **117**(6), pp. 1078-1086.

DOI 10.2478/afepuc-2022-0004
© Acta Facultatis Educationis Physicae Universitatis Comenianae 2022, 62(1): 27-40

THE ACUTE EFFECTS OF DIFFERENT WARM-UP PROTOCOLS ON SOME PERFORMANCE PARAMETERS IN U11-16 SOCCER PLAYERS

Muhammed Mustafa Aktaş, Doğuş Bakıcı, Ertuğrul Gelen, Ayşenur Turgut Kaymakçı
Sakarya University of Applied Sciences, Faculty of Sport Sciences, Turkey

Summary: Purpose: The purpose of the study is to examine the acute effects of different warm-up protocols on some physical performance parameters in the Under 11-16 (U11-16) category soccer players. **Material and Methods:** The participant group of the study consisted of seventy-two male soccer players who regularly train in the U11-16 category. Soccer players randomly and counterbalanced participated in the one of the warm-up protocols of FIFA 11+, HarmoKnee, Dynamic warm-up, or Mixed warm-up on non-consecutive days. After participants performed one of the protocols, their flexibility, vertical jump, 30m sprint, and agility performances were measured. Repeated measures in the ANOVA test were used to determine intra-group differences (U11-U12-U13-U14-U15-U16) and Bonferroni test was used to decide which protocol caused a significant difference.
Results: In all underage categories, FIFA 11+, HarmoKnee, and dynamic warm-up caused a significant difference in flexibility, vertical jump, 30 m sprint, and agility compared to Mixed warm-up ($p < 0.05$).
Conclusions: As a result of the study, it was shown that FIFA 11+, HarmoKnee, and dynamic warm-up protocols acutely caused a positive influence in flexibility, vertical jump, 30 m sprint, and agility in all underage categories. These three warm-up protocols may be used to prevent athletes from warm-up uniformity and monotony and support multidirectional development.

Keywords: Fifa11+; Harmoknee; Dynamic Warm-up; Countermovement Jump; Agility; Flexibility

Introductıon

A competition and training warm-up (WU) is performed to optimize neural, metabolic, and temperature-related factors of the body such as increasing contraction velocity, improving strength and power outputs and oxygen-carrying capacity (Jeffreys 2007; McGowan, Pyne, Thompson, Rattray 215). Recently soccer-specific warm-up programs have evolved to a more comprehensive style. Specifically, exercises in these protocols have been split into different named sections and categories and they do not only consider optimization of the performance but also injury prevention and long-term

development (Ayala, Calderón-López, Delgado-Gosálbez, Parra-Sánchez, Pomares-Noguera, Hernández-Sánchez et al., 2017; Kiani, Hellquist, Ahlqvist, Gedeborg, Michaëlsson, Byberg, 2010).

FIFA 11+ and HarmoKnee are two well-known warm-up protocols used in soccer (Balsalobre-Fernández, Glaister, Lockey 2015; Bizzini, Junge & Dvorak 2013; Daneshjoo, Mokhtar, Rahnama, 2013).

FIFA 11+ aims to standardize the warm-up of amateur soccer players while preventing injuries (Ayala, Calderón-López, Delgado-Gosálbez, Parra-Sánchez, Pomares-Noguera, Hernández-Sánchez et al. 2017; Bizzini, Junge & Dvorak 2013). Similarly, HarmoKnee aims to prevent knee injuries while improving movement (Kiani, Hellquist, Ahlqvist, Gedeborg, Michaëlsson, Byberg, 2010). Ayala (2017) showed that the FIFA 11+, HarmoKnee, and dynamic WU acutely induced identical results in developing the range of motion, jumping height in amateur, young females, and male soccer players. In another study (Bizzini 2013) concluded that FIFA 11+ caused better acute performance improvement in sprint, agility, and jumping heights compared to Dynamic WU. Similarly, dynamic WU acutely caused better jumping height and long jump performances in children (Faigenbaum, Bellucci, Bernieri, Bakker, Hoorens 2005; Gelen 2011). In the youth population, training versatility is an important aspect to create and support multidirectional development (Balyi, Way, Higgs 2013; Bompa, Carrera 2015).

Generally, training versatility is considered only for the main phase of the session training. However, the inclusion of the different sort of comprehensive warm-ups periodically may avoid athletes from warm-up uniformity and monotony as long as they similarly optimize and enhance training performance. Although studies previously investigated the acute effects of FIFA 11+, HarmoKnee, and dynamic WU, none of these studies showed their influences in underage categories (U11-12-13-14-15-16). Previously conducted studies in the young population investigated relatively longer-term effects of FIFA 11+ and HarmoKnee (Akbari, Sahebozamani, Daneshjoo, Amiri-Khorasani 2018; Zarei, Abbasi, Daneshjoo, Barghi, Rommers, Faude et al. 2018).

However, we do not know the acute effects of warm-ups in mentioned population. Since the study's purpose is to examine the acute effects of four different warm-up protocols (FIFA 11+, HarmoKnee, dynamic and mixed) on sprint, agility, jumping, and flexibility in U11-12-13-14-15-16 soccer players.

Material and method

Participants

Seventy-two soccer players who compete in the U11-16 (twelve from each) categories participated in the study (Table 1). Participants did not have any musculoskeletal injury in the last 6 months. There was not a familiarization period due to the fact participant's tests regularly are taken. Families were informed and their signed permissions were taken before the study. Ethical committee approval was obtained from Sakarya University of Applied Sciences. In every phase of the study, the Helsinki declaration was followed. As for the ethical issues, it was approved by University Sakarya Social and Human Sciences Ethics Committee on 04.10.2018 (protocol number: 61923333/050.03/).

Table 1

Anthropometric characteristics of the participants

	Average Values					
Age (years)	U11	U12	U13	U14	U15	U16
Body Mass [kg]	35,33 ± 1,7	36,16 ± 2,0	39,91 ± 3,0	57,91 ± 3,5	61,33 ± 2,8	72,16 ± 3,9
Height [cm]	145,58 ± 1,5	142,5 ± 1,3	149,33 ± 2,4	170,66 ± 2,3	172,58 ± 1,9	175,83 ± 3,0

Experimental Approach to the Problem

The study was designed randomly and counterbalanced. Participants' countermovement jump (CMJ), 30 m sprint, Illinois agility, and sit and reach flexibility test were measured after they performed one of the warm-up protocols (FIFA 11+, HarmoKnee, Dynamic warm-up, and Mixed warm-up). The mixed WU protocols were designed as the control protocol, and the other warm-up protocols were designed as the experimental. During this process, any of the participants did not mention any physical problem. Between tests, 2-3 minutes of rest intervals were given. All procedures were performed during one week on non-consecutive days (Monday, Wednesday, Friday, and Sunday). All warm-up and test procedures were conducted at the same time of the day considering diurnal variation. Illinois and 30 m sprint tests were measured in the soccer field while CMJ and flexibility tests were measured on a proper and flat surface by the field. Participants did not perform any physical activity 48 hours before and on the test day. Nutrition consumption was completed 2.5 hours before procedures on the test day. All authors supervised during warm-up and measurement processes.

Warm-up Protocols

FIFA 11+

Volume and intensity adjustments and exercise selections were obtained from the study of Ayala and Bizzini 11+ manual (Ayala, Calderón-López, Delgado-Gosálbez, Parra-Sánchez, Pomares-Noguera, Hernández-Sánchez et al. 2017; Bizzini, Junge & Dvorak 2013). FIFA 11+ contained three sections. The first section included six exercises that consisted of jogging and dynamic stretching (8 minutes). The second section focused on strength-plyometric-balance exercises (10 minutes). The third section consisted of competition and training like running and cutting movements (2 minutes). FIFA 11+ protocol was completed in 20 minutes. All the groups performed level two exercises. Even if we are aware of FIFA 11+ kids are recommended for <14 years old. A study previously used the regular FIFA 11+ warm-up protocol on 10 years old children (Gatterer, Lorenzi, Ruedl, Burtscher 2018).

HarmoKnee Warm-up

Volume and intensity adjustments and exercise selections were obtained from the study of Ayala (Ayala, Calderón-López, Delgado-Gosálbez, Parra-Sánchez, Pomares-Noguera, Hernández-Sánchez et al. 2017). HarmoKnee warm-up protocol contained five sections of warm-up, muscle activation, balance, strength, and core stability, respectively. The first section included five exercises that consisted of jogging, dynamic stretching, and game-based applications (10 minutes). The second section included six exercises that focused on lower extremity muscle activation (2 minutes). The third section included four exercises that consisted of static and dynamic balance skills (2 minutes). The fourth section consisted of three exercises aimed to optimize specific movement patterns with 12-15 repetitions (4 minutes). The fifth and the last section included torso activation and core stability exercises (4 minutes). HarmoKnee protocol was completed in 20-25 minutes.

Dynamic Warm-up

Volume and intensity adjustments and exercise selections were obtained from the study of Taylor and Ayala (Ayala, Calderón-López, Delgado-Gosálbez, Parra-Sánchez, Pomares-Noguera, Hernández-Sánchez et al. 2017; Taylor, Sheppard, Lee, Plummer 2009). The dynamic WU consisted of sixteen exercises that were not specifically split into labeled sections. Activities focused on dynamic stretching, jump, and sprint movements. The dynamic WU protocol was completed in 20-25 minutes.

Mixed Warm-up

The mixed WU consisted of jogging (5 minutes), dynamic (5 minutes) and static stretching (5 minutes) and jogging again (5 minutes). The mixed WU was completed in 20 minutes.

Measurement Procedures

Sit and Reach test

In this test, lower back and lower body posterior muscles' flexibility was assessed. The participant sat and placed his foot to the specific area on the box and then positioned his palms on the gauge showing downwards. While maintaining his knee and ankle extension during the test, tried to move the gauge as far as possible. At the farthest point, he kept his position for two seconds and the test is recorded in centimeter (cm). Two trials were performed, and the best was recorded for data analysis (Jürimäe, Volbekiene1998).

Countermovement Jump

Participant placed his feet straight at the shoulder width and placed his hands on the waist. After squatted to the preferred depth, then immediately jumped. Jumping video recorded with a phone's camera (240 frames/sec). MyJump2 application used to evaluate jump height calculating take-off and landing frames (Balsalobre-Fernández, Glaister, Lockey 2015; Turgut, Çoban, Gelen 2018). Two trials were performed, and the best recorded for data analysis.

30 m Sprint Test

The photocell gates were placed to starting and ending (30 m) points (SE-200 Photocell Gate, İstanbul, Turkey). Participants were asked to cover the distance between the two gates as fast as possible. Two trials were performed, and the best recorded for data analysis (Rommers, Mostaert, Goossens, Vaeyens, Witvrouw, Lenoir et al. 2019).

Illinois Agility Test

Four cones 10 m in length and 5 m in width to each other (square shape) were placed. Photocell gates were positioned to starting and ending points (SE-200 Photocell Gate, İstanbul, Turkey). The other four cones are sequenced and separated 3.3 m from each other and placed in the middle. The sequence was followed during the test; 1-) 10 m run and turn, 2-) go to middle and pass-through cones, 3-) run to next cone up right corner 4-) run to finishing line (Figure 1). Two trials were performed, and the best recorded for data analysis (Reiman, Manske 2009).

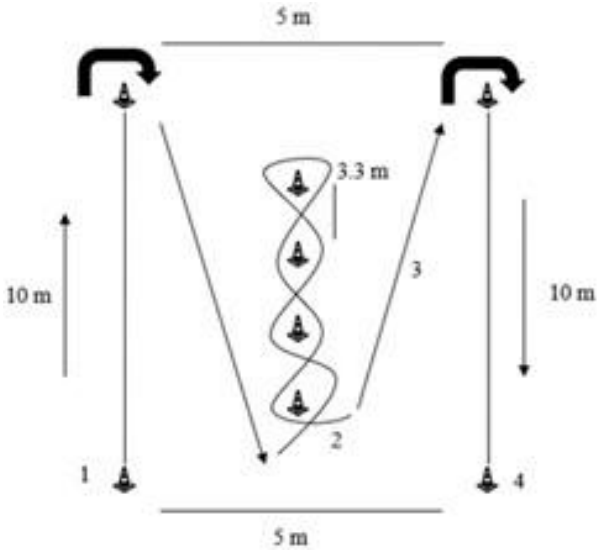


Figure 1
Illınois Agility Test

Statistical Analyses

The means and standard deviation values of all variables were calculated. The Shapiro-Wilk test was used to determine the normality of the data. Repeated measures of the ANOVA test were used to decide intra-group differences (U11-U12-U13-U14-U15-U16) and Bonferroni test was used to determine which protocol caused a significant difference. While the reliability of each test between different warm-ups was determined using the Intra-Class Correlation Coefficient (ICC), the within-test reliability was expressed as the Coefficient of Variation (% CV) (Hopkins 2000). Statistical significance was set at $p < 0.05$. Statistical Package for the Social Sciences (SPSS 16.0, Inc. Chicago, IL) was used to evaluate the results.

Results

The results of the analysis are given below. CV values for all protocols showed moderate confidence (CV% range: 0.64-1.75). ICC values for all protocols were observed as good agreement (ICC: 740-, 895). The acute effects of WU protocols on athletic performance by age are presented in Table 2, 3, 4, 5**.**

Agility Performance

Among the WU protocols, CV values were between 0.80-1.55 and ICC values were in the range of 750-.810. A significant difference was found between the WU protocols in all age groups (i.e; U11 x Fifa11+, Harmoknee, Dynamic WU, Mixed WU) ($p < 0.001$; U11 F = 15730.811; U12 F = 53009.214; U13 F = 226.563; U14 F = 329.669; U15 F = 224.967; U16 F

= 159.843, U11, U12, U13, U14, U15, U16 respectively). A significant difference was found between the age groups of all WU protocols (i.e; Fifa11+ x U11-12-13-14-15-16) ($p < 0.05$; $F = 14.837$; $F = 21.136$; $F = 14.281$; $F = 28.925$, Fifa11+, Harmoknee, Dynamic WU, Mixed WU respectively).

Table 2

The acute effects of WU Protocols on Agility Test by age

Age Groups	FIFA+11 WU	Harmoknee WU	Dynamic WU	Mixed WU	Significance
U11	21,10 ± 1,3 s	21,33 ± 0,5 s	20,99 ± 0,9 s	25,71 ± 0,2 s	p < 0,001
U12	21,06 ± 0,8 s	20,78 ± 0,4 s	21,07 ± 0,4 s	25,81 ± 0,3 s	p < 0,001
U13	20,02 ± 1,0 s	20,02 ± 0,8 s	20,00 ± 0,9 s	25,45 ± 0,3 s	p < 0,001
U14	18,44 ± 1,2 s	18,73 ± 0,7 s	18,72 ± 0,9 s	25,08 ± 0,1 s	p < 0,001
U15	18,84 ± 1,1 s	18,76 ± 1,3 s	18,82 ± 1,0 s	25,14 ± 0,3 s	p < 0,001
U16	18,82 ± 0,5 s	19,03 ± 0,8 s	19,08 ± 1,2 s	24,48 ± 0,3 s	p < 0,001
Significance	p < 0,05	p < 0,05	p < 0,05	p < 0,05	

30 m Sprint Performance

Within the WU protocols, CV values ranged from 0.69-1.32 and ICC values in the range 862-, 889. A significant difference was found between the WU protocols in all age groups (i.e; U11 x Fifa11+, Harmoknee, Dynamic WU, Mixed WU) ($p < 0.001$; $F = 32.925$, $F = 51.018$; $F = 35.529$; $F = 60.958$; $F = 55.477$; $F = 50.881$ U11, U12, U13, U14, U15, U16 respectively). A significant difference was found between the age groups of all WU protocols (i.e; Fifa11+ x U11-12-13-14-15-16) ($p < 0.05$; $F = 22.417$; $F = 18.133$; $F = 28.925$; $F = 35.182$, Fifa11+, Harmoknee, Dynamic WU, Mixed WU respectively).

Table 3

The acute effects of WU Protocols on 30 m Sprint test by age

Age Groups	FIFA+11 WU	Harmoknee WU	Dynamic WU	Mixed WU	Significance
U11	6,31 ± 0,4 s	6,55 ± 0,4 s	6,21 ± 0,2 s	7,16 ± 0,2 s	p < 0,001
U12	6,28 ± 0,3 s	6,20 ± 0,3 s	6,31 ± 0,3 s	7,07 ± 0,3 s	p < 0,001
U13	5,93 ± 0,3 s	5,93 ± 0,2 s	5,95 ± 0,3 s	6,74 ± 0,2 s	p < 0,001
U14	5,53 ± 0,4 s	5,63 ± 0,3 s	5,58 ± 0,1 s	6,38 ± 0,2 s	p < 0,001
U15	5,55 ± 0,3 s	5,66 ± 0,2 s	5,64 ± 0,3 s	6,42 ± 0,2 s	p < 0,001
U16	5,03 ± 0,3 s	5,33 ± 0,4 s	4,98 ± 0,3 s	5,92 ± 0,2 s	p < 0,001
Significance	p < 0,05	p < 0,05	p < 0,05	p < 0,05	

Flexibility Performance

Among the WU protocols, CV values were in the range of 0.87-1.44 and ICC values were in the range of 790-, 867. While there was a significant difference between the WU protocols in all age groups (i.e; U11 x Fifa11+, Harmoknee, Dynamic WU, Mixed WU) ($p < 0.001$; $F = 199.126$, $F = 63.020$; $F = 66.545$; $F = 64.571$; $F = 85.951$, U11, U12, U13, U15, U16 respectively), there was no significant difference among the WU protocols in the U14 age group ($p > 0.05$; $F = 152.814$). There was no significant difference between the age groups of all WU protocols (i.e; Fifa11+ x U11-12-13-14-15-16) ($p > 0.05$; $F = 1.794$; $F = 1.984$; $F = 1.720$; $F = 2.032$ Fifa11+, Harmoknee, Dynamic WU, Mixed WU respectively).

Table 4

The acute effects of WU Protocols on Flexibility Test by age

Age Groups	FIFA+11 WU	Harmoknee WU	Dynamic WU	Mixed WU	Significance
U11	17,41 ± 5.3 cm	18,00 ± 4,1 cm	17,25 ± 4,3 cm	15,75 ± 4,1 cm	p < 0,001
U12	12,66 ± 6.0 cm	14,00 ± 5,1 cm	13,08 ± 5,9 cm	11,41 ± 5,6 cm	p < 0,001
U13	15,66 ± 6.2 cm	16,00 ± 6,6 cm	15,83 ± 7,0 cm	13,41 ± 6,1 cm	p < 0,001
U14	18,66 ± 5.6 cm	18,33 ± 5,6 cm	19,25 ± 4,8 cm	17,5 ± 5,6 cm	p > 0,05
U15	13,91 ± 6.0 cm	13,83 ± 5,9 cm	14,75 ± 6,1 cm	13,16 ± 6,0 cm	p < 0,001
U16	17,83 ± 7.1 cm	19,41 ± 6,7 cm	17,75 ± 6,4 cm	16,91 ± 6,9 cm	p < 0,001
Significance	p < 0,05	p < 0,05	p < 0,05	p < 0,05	

CMJ Performance

Within the WU protocols, CV values ranged from 0.79-1.75 and ICC values in the range of 799-, 895. A significant difference was found between the WU protocols in all age groups (i.e; U11 x Fifa11+, Harmoknee, Dynamic WU, Mixed WU) ($p < 0.001$; $F = 467.992$; $F = 364.201$; $F = 527.159$; $F = 407.248$; $F = 281.272$; $F = 283.168$ U11, U12, U13, U14, U15, U16 respectively). A significant difference was found between the age groups of all WU protocols (i.e; Fifa11+ x U11-12-13-14-15-16) ($p < 0.05$; $F = 10.151$, $F = 9.762$; $F = 10.470$; $F = 10.395$; Fifa11+, Harmoknee, Dynamic WU, Mixed WU respectively).

Table 5

. The acute effects of WU Protocols on CMJ Test by age

Age Groups	FIFA+11 WU	Harmoknee WU	Dynamic WU	Mixed WU	Significance
U11	24,00 ± 3.1 cm	24,58 ± 4,6 cm	24,16 ± 3,9 cm	23,16 ± 3,8 cm	p < 0,001
U12	26,58 ± 4.6 cm	27,66 ± 4,6 cm	27,16 ± 5,5 cm	26,16 ± 4,9 cm	p < 0,001
U13	27,66 ± 4.3 cm	27,33 ± 4,1 cm	27,83 ± 4,3 cm	26,75 ± 4,1 cm	p < 0,001
U14	35,25 ± 5.6 cm	35,0 ± 6,4 cm	35,33 ± 6,4 cm	34,08 ± 6,0 cm	p < 0,001
U15	32,25 ± 6.8 cm	31,83 ± 6,4 cm	32,33 ± 6,6 cm	31,08 ± 6,5 cm	p < 0,001
U16	37,66 ± 8.5 cm	38,75 ± 8,0 cm	38,05 ± 7,3 cm	37,25 ± 7,7 cm	p < 0,001
Significance	p < 0,05	p < 0,05	p < 0,05	p < 0,05	

Discussion

The study aimed to examine the acute effects of the different warm-up protocols on CMJ, flexibility, agility, and sprint performances of soccer players in the U11-16 age groups. In the study, it was found that FIFA 11+, HarmoKnee, dynamic WU protocols were more effective on agility, sprint, CMJ, and Flexibility compared to the mixed WU protocol in the U11-16 age groups as hypothesized. Another important finding was that regardless of the type of warm-up, athletes' jump and sprint performances showed an increment with age.

In the study, it was shown that FIFA 11+, HarmoKnee, and dynamic WU protocols all positively influence agility, sprint, and CMJ performances. Studies in the literature support these results. In a study, Gelen, showed that acute dynamic warm-up increased CMJ height in athletes from different sports (13.3 ± 0.5 years) (Gelen 2011). In another study, Ayala, indicated that any of the FIFA 11+, HarmoKnee, and dynamic warm-up did not cause superior results than another to improve drop jump performance in male and female athletes (19.1 ± 1.3, 20.1 ± 1.8 years) (Ayala, Calderón-López, Delgado-Gosálbez, Parra-Sánchez, Pomares-Noguera, Hernández-Sánchez et al. 2017). However, they concluded that dynamic WU was better to enhance 10 and 20 m sprint performance than FIFA 11+ and HarmoKnee. In another study, it was shown that the FIFA 11+ positively influenced agility performance (Bizzini, Junge & Dvorak 2013). In his study, Gelen, stated that dynamic warm-up caused an increase in muscle stiffness and nervous system activation (Gelen 2011). Bizzini, argued that agility performance enhancement was caused by the rise in muscle and/or core temperature reporting from other studies (Kiani, Hellquist, Ahlqvist, Gedeborg, Michaëlsson, Byberg, 2010; Bizzini, Impellizzeri, Dvorak, Bortolan, Schena, Modena et al. 2013; Thomas, Cheung, Elder, Sleivert 2006). In addition to these explanations, we think that the results are caused by the Post

Activation Potentiation (PAP) effect due to the phosphorylation of myosin regulating light chains which makes actin and myosin more sensitive to ca^{2+}(Hodgson, Docherty, Robbins 2005). Even if there are no additional load interventions in FIFA 11+, HarmoKnee, and dynamic WU protocols of the current study, in support of this claim, other studies showed that small-sided games and relatively low loads corresponding to 5-10 % of body weight elicited the PAP effect (Maloney, Turner, Miller 2014; Zois, Bishop, Ball, Aughey 2011). On the other hand, the mixed WU protocol caused a significantly lower performance compared to other protocols, given that it includes static stretching (SS). It was indicated in a study that during SS alterations in muscle-tendon unit length may impair the force-generation capacity of the muscle, since it may result in a decrease in muscle stiffness (Hough, Ross, Howatson 2009).

Ayala (2017) showed that acutely any of the FIFA 11+, HarmoKnee, and dynamic WU was not more effective than each other to improve the hip, knee, and ankle joint's range of motion. Similarly, in another study, one of the FIFA 11+ and regular warm-up protocols acutely did not cause improvement in the range of motion of the hip, knee, and ankle joints of adolescent athletes (Robles, Pomares Noguera, Ayala Rodríguez, Hernández Sánchez, Martínez Romero, Sainz de Baranda Andújar et al. 2016). In our study, all warm-up protocols except mixed WU revealed similar adaptations in flexibility performance. Although it was previously indicated that the inclusion of static stretching was effective to improve the range of motion (Samson, Button, Chaouachi, Behm 2012). In the support of our findings, another study showed that both static and dynamic stretching included warm-ups positively affected the sit and reach performance (Perrier, Pavol, Hoffman 2011). In our study, dynamic stretching, and specific movement pattern applications at the wide range of motions in FIFA 11+, HarmoKnee and dynamic WU protocols may have induced positive adaptations.

The CMJ and sprint performances of the athletes in U11-12-13-14-15-16 age groups linearly improved, except CMJ height of the athletes in the U15 group did not advance compared to the previous age, In a study, Temfemo, found that boys and girls between 11-16 years old linearly improved their jumping performance by age (Temfemo, Hugues, Chardon, Mandengue, Ahmaidi 2009). They explained that this development was induced muscular development as well as reporting from Bobbert and Casius, changes in the length of contractile elements in the muscle-tendon structure (Bobbert, Casius 2005). Especially, the development of the tendon structure length increases its energy storage capacity (Challis 2000). The energy storage capacity of the tendon is important in movements that use the stretch-shortening cycle, such as CMJ and sprint. It was reported that children are in the adolescent period between 12 and 16 years old, the improvement is naturally obtained through maturation-related adaptations

such as increased androgen concentration, muscle fibril differentiation, changes in resting adhesonine triphosphate, and creatine phosphate levels (Lloyd, Oliver 2012). The anatomical and physiological developments with maturation explain the improvement in sprint and jump performances that occur independently from the warm-up.

Conclusions

FIFA 11+, HarmoKnee, and dynamic WU showed identical effects in U11-16. Firstly, FIFA 11+ and HarmoKnee can be preferable compared to dynamic WU since they both promise injury prevention and do not have any performance impairment. Secondly, all these three comprehensive and dynamic warm-up protocols can be used to avoid young athletes from warm-up monotony. Additionally, it should be kept in mind that growth and maturation-related factors can have a significant effect on warm-up and test performance.

References

1. JEFFREYS, I., 2007. Warm up revisited – the 'ramp' method of optimising performance preparation. *Prof Strength Cond*. **6**(44): 12-8.
2. McGOWAN, C. J., D. B. Pyne, K. G. Thompson, B. Rattray, 2015. Warm-Up Strategies for Sport and Exercise: Mechanisms and Applications. *Sport Med*. **45**(11): 1523-46. doi: 10.1007/s40279-015-0376-x.
3. AYALA, F., A. CALDERÓN-LÓPEZ, J. C. DELGADO-GOSÁLBEZ, S. PARRA-SÁNCHEZ, C. POMARES-NOGUERA, S. HERNÁNDEZ-SÁNCHEZ et al., 2017. Acute effects of three neuromuscular warm-up strategies on several physical performance measures in football players. *PLoS One*. **12**(1). doi: 10.1371/journal.pone.0169660.
4. KİANİ, A., E. HELLQUİST, K. AHLQVİST, R. GEDEBORG, K. MİCHAËLSSON, L. BYBERG, 2009. Prevention of soccer-related knee injuries in teenaged girls. *Arch Intern Med*. **170**(1): 43–9. doi: 10.1001/archinternmed.
5. BALSALOBRE-FERNÁNDEZ, C., M. GLAİSTER, R. A. LOCKEY, 2015. The validity and reliability of an iPhone app for measuring vertical jump performance. *J Sports Sci.* **33**(15): 1574-9. doı: 10.1080/02640414.2014.996184.
6. BİZZİNİ, M., A. JUNGE & J. DVORAK, 2013. Implementation of the FIFA 11+ football warm up program: how to approach and convince the Football associations to invest in prevention. *British journal of sports medicine*. **47**(12): 803-806. doi: 10.1136/bjsports-2012-092124.

7. DANESHJOO, A., A. H. MOKHTAR, N. RAHNAMA, A. YUSOF, 2013. Effects of the 11+ and Harmoknee warm-up programs on physical performance measures in professional soccer players. *J Sport Sci Med*. **12**(3): 489-96.
8. FAİGENBAUM, A. D., M. BELLUCCİ, A. BERNİERİ, B. BAKKER, K. HOORENS, 2005. Acute effects of different warm-up protocols on fitness performance in children. *J Strength Cond Res.***19**(2): 376-81. doi: 10.1519/R-15344.1.
9. GELEN, E., 2011. Acute effects of different warm-up methods on jump performance in children. *Biol Sport*. **28**(2): 133-8. doi: 10.5604/947456.
10. BALYİ, I., R. WAY, C. HİGGS, 2013. Long-Term Athlete Development. *Human Kinetics, Inc*. doi: 10.5040/9781492595373.ch-023.
11. BOMPA, T., M. CARRERA, 2015. Conditioning Young Athletes. *Human Kinetics*.
12. AKBARİ, H., M. SAHEBOZAMANİ, A. DANESHJOO, M. AMİRİ-KHORASANİ, 2018. Effect of the FIFA 11+ programme on vertical jump performance in elite male youth soccer players. Montenegrin *J Sport Sci Med*. **7**(2):17-22. doi: 10.26773/mjssm.180903.
13. ZAREİ, M., H. ABBASİ, A. DANESHJOO, T. S. BARGHİ, N. ROMMERS, O. FAUDE et al., 2018. Long-term effects of the 11+ warm-up injury prevention programme on physical performance in adolescent male football players: a cluster-randomised controlled trial. *J Sports Sci*. **36**(21): 2447-54. doi: 10.1080/02640414.2018.1462001.
14. GATTERER, H., D. LORENZİ, G. RUEDL, M. BURTSCHER, 2018. The "FIFA 11+" injury prevention program improves body stability in child (10 year old) soccer players. *Biol Sport.* **35**(2): 153-8. doi: 10.5114/biolsport.2018.71604.
15. TAYLOR, K. L., J. M. SHEPPARD, H. LEE, N. PLUMMER, 2009. Negative effect of static stretching restored when combined with a sport specific warm-up component. *J Sci Med Sport*. **12(**6): 657-61. doi: 10.1016/j.jsams.2008.04.004.
16. JÜRİMÄE, T., V. VOLBEKİENE, 1998. Eurofit Test Results in Estonian and Lithuanian 11 to 17-Year-Old Children: A Comparative Study. *Eur J Phys Educ*. **3**(2): 178-84. doi: 10.1080/1740898980030206.
17. TURGUT, A., G. O. ÇOBAN, E. GELEN, 2018. Dikey sıçrama performansının belirlenmesinde akıllı telefon uygulaması kullanılabilir mi? *Uluslararası Spor Egzersiz ve Antrenman Bilim Derg.* **4**(2): 79-83. doi: 10.18826/useeabd.437153.
18. ROMMERS, N., M. MOSTAERT, L. GOOSSENS, R. VAEYENS, E. WİTVROUW, M. LENOİR et al., 2019. Age and maturity related differences in motor coordination among male elite youth soccer players. *J Sports Sci.* **37**(2): 196-203. doi: 10.1080/02640414.2018.1488454

19. REİMAN, M. P., R. C. MANSKE, 2009. Functional Testing in Human Performance. *Human Kinetics*. doi: 10.5040/9781492596882.
20. HOPKİNS, W. G., 2000. Measures of reliability in sports medicine and science. *Sport Med.* **30**(1): 1-15. doi: 10.2165/00007256-200030010-00001.
21. BİZZİNİ, M., F. M. IMPELLİZZERİ, J. DVORAK, L. BORTOLAN, F. SCHENA, R. MODENA et al., 2013. Physiological and performance responses to the "FIFA 11+" (part 1): is it an appropriate warm-up? *J Sports Sci*. **31**(13): 1481.90. doi: 10.1080/02640414.2013.802922
22. THOMAS, M. M., S. S. CHEUNG, G. C. ELDER, G. G. SLEİVERT, 2006. Voluntary muscle activation is impaired by core temperature rather than local muscle temperature. *J Appl Physiol.* **100**(4): 1361-9. doi: 10.1152/japplphysiol.00945.2005.
23. HODGSON, M., D. DOCHERTY, D. ROBBİNS, 2005. Post-activation potentiation: Underlying physiology and implications for motor performance. *Sport Med*. **35**(7): 585-95. doi: 10.2165/00007256-200535070-00004.
24. MALONEY, S. J., A. N. TURNER, S. MİLLER, 2014. Acute effects of a loaded warm-up protocol on change of direction speed in professional badminton players. *J Appl Biomech.* **30**(5): 637-42. doi: 10.1123/jab.2014-0048.
25. ZOİS, J., D. J. BİSHOP, K. BALL, R. J. AUGHEY, 2011. High-intensity warm-ups elicit superior performance to a current soccer warm-up routine. *J Sci Med Sport.* **14**(6): 522-8. doi: 10.1016/j.jsams.2011.03.012.
26. HOUGH, P. A., E. Z. ROSS, G. HOWATSON, 2009. Effects of dynamic and static stretching on vertical jump performance and electromyographic activity. *J Strength Cond Res*. **23**(2): 507-12. doi: 10.1519/JSC.0b013e31818cc65d.
27. ROBLES, F., C. POMARES NOGUERA, F. AYALA RODRÍGUEZ, S. HERNÁNDEZ SÁNCHEZ, M. MARTÍNEZ ROMERO, M. SAİNZ DE BARANDA ANDÚJAR et al., 2016. Acute and chronic effects of the FIFA 11+ on several physical performance measures in adolescent football players. *Eur J Hum Mov*. **36**: 116-136.
28. SAMSON, M., D. C. BUTTON, A. CHAOUACHİ, D. G. BEHM, 2012. Effects of dynamic and static stretching within general and activity specific warm-up protocols. *J Sport Sci Med.* **11**(2): 279-85.
29. PERRİER, E. T., M. J. PAVOL, M. A. HOFFMAN, 2011. The acute effects of a warm-up including static or dynamic stretching on countermovement jump height, reaction time, and flexibility. *J Strength Cond Res.* **25**(7): 1925–31. doi: 10.1519/JSC.0b013e3181e73959.

30. TEMFEMO, A., J. HUGUES, K. CHARDON, S. H. MANDENGUE, S. AHMAİDİ, 2009. Relationship between vertical jumping performance and anthropometric characteristics during growth in boys and girls. *Eur J Pediatr*. **168**(4): 457-64. doi: 10.1007/s00431-008-0771-5.
31. BOBBERT, M. F., L. J. R. CASİUS, 2005. Is the effect of a countermovement on jump height due to active state development? *Med Sci Sports Exerc*. **37**(3): 440-6. doi: 10.1249/01.mss.0000155389.34538.97.
32. CHALLİS, J. H., 2000. Muscle-Tendon Architecture and Athletic Performance. In: *Biomechanics in Sport*. p: 33–55 (Wiley Online Books). doi: 10.1002/9780470693797.ch3.
33. LLOYD, R. S., J. L. OLİVER, 2012. The youth physical development model: A new approach to long-term athletic development. *Strength Cond J*. **34**(3): 61-72. doi: 10.1519/SSC.0b013e31825760ea.

DOI 10.2478/afepuc-2022-0005
© Acta Facultatis Educationis Physicae Universitatis Comenianae 2022, 62(1): 41-52

IMPACT OF COVID-19 PANDEMIC ON PSYCHICAL HEALTH AND SOCIAL RELATIONSHIPS AMONG UNIVERSITY STUDENTS

Rút Lenková, Frederika Pajonková, Tamara Lukáčová

University of Prešov, Faculty of Sports, Slovakia

Summary: We have never faced such a global pandemic as COVID-19 in modern history. It´s important for us to find out how it can affect mental health and social relationships of students. This pandemic has brought us not only the risk of dying from a viral infection, but also brought the enormous psychological pressure on people. Purpose of this study was to determine the impact of COVID-19 pandemic on mental health and social relationships of university students. **Methods:** The research group consisted of 95 students of the Faculty of Sports of the University of Prešov in Prešov (men: n = 62, women: n = 33) with an average age of 22 +/- 6 years. As a method of data collection we used the standardized questionnaire of the World Health Organization - WHOQOL-BREF. Our modified WHOQOL-BREF questionnaire represents a selection of 9 items, six of them represent mental health: (1) Positive feeling (2) Self-esteem (3) Thinking, learning, memory and concentration (4) Bodily image and appearance, (5) Satisfy with you, (6) Negative feelings, and three represent social relationships (7) Personal relationships, (8) Sexual activity, (9) Social support. Due to the extraordinary pandemic situation an online survey was conducted to the students. Students had time to complete the questionnaire from 17.11.2021 to 19.11.2021. **Results:** Statistical significant difference between periods before and during COVID-19 pandemic was determined using the Wilcoxon paired t test. There were statistically significant differences in the psychological experience and social relationships of university students before and during the COVID-19 pandemic. **Conclusion:** We recommend monitoring the mental health of university students and raising awareness of various media platforms about psychological problems during a pandemic.

Key words: Undergraduate students, pandemic, mental health, social relationships

Introduction

The Slovak Republic is also one of the countries affected by the global pandemic COVID-19. The COVID-19 pandemic can be considered like a huge and uncontrollable stressor

that has a significant effect on mental health of individuals (Zhang et al. 2020).

The pandemic interferes with everyday life and quality of life, what confirm the data from the Chinese and Iranian population (Qiu et al. 2020; Zandifar & Badrfam 2020; Moghanibashi-Mansoureih 2020). Students are one of that group of people affected by the restrictions of the COVID-19 pandemic. Since the beginning of the pandemic students have been carrying out the educational process through distance learning (Grajek and Sobczyk 2021). Difficulties in schoolwork, restrictions, reduced social interaction, changes of their daily routine and boredom can make a huge psychological effect on adolescents (Zhang et al. 2020).

Separation from loved ones, the feeling of helplessness, loss of freedom are things related to the pandemic that affect the population (Li and Wang 2020; Cao et al. 2020). Research done during the COVID-19 pandemic shows that especially children and young adults are at risk of developing anxious symptoms (Orgilés et al. 2020). These symptoms are also related with the economic problems and the slowdown in academic activities (Alvarez, Argente & Lippi 2020).

The authors Szczepańska & Pietrzyka (2021) conducted research during the first lockdown in Poland in April 2020. The study group was composed of 132 respondents who were university students aged 19 – 26. The study demonstrated that the restrictions enforced during the COVID-19 pandemic contributed to a significant decline in the mood, psychological well-being and quality of life of young adults. Similar results were reported by researchers in other countries (Beam and Kim 2020; Liu et al. 2020; Liu et al. 2020; Parola et al. 2020; Shanahan et al. 2020; Volk et al. 2020; Zheng et al. 2020, in Szczepańska and Pietrzyka 2021). Limited access to public spaces was strongly correlated with a decline in the students' psychological well-being. According to the respondents, the significant decrease in the frequency of visits to open and closed public spaces, and the resulting decline in physical and social activities (human interactions) had a highly negative impact. The same results were found by Park et al. (2021), their study aimed to investigate the impact of the COVID-19 pandemic on these factors in Koreans over 20 years old. The study sample consisted of 104 adults in South Korea aged over 20 years. Participants reported that their quality of life and mental health had decreased after the pandemic struck.

The authors Cam et al. (2021) investigated the impact of the COVID-19 pandemic on mental and physical health-related quality of life among university students in Turkey. Overall, they diagnosed students with symptoms of depression (64.6 %), anxiety (48.6 %), stress (45.3 %) and post-traumatic stress disorder (34.5 %). The findings of this study also confirm that post-traumatic stress disorder was significantly associated with poor health-related quality

of life, and that these negative feelings were common during the COVID-19 pandemic. Similarly, Qanash et al. (2020) found in their research that health care students have high levels of anxiety and depression during the COVID-19 pandemic.

In contrast, the findings of Al Dhaheri et al. (2021) showed the positive impact of the COVID-19 pandemic on family support and mental health awareness. Similarly, Gijzen et al. (2020) found that more than half of the participants in their study reported the positive consequences of the COVID-19 pandemic. This is comparable to SARS pandemic study from 2003, in which most participants were able to identify both negative and positive consequences of a pandemic outbreak, even though they were directly affected by SARS (Cheng et al. 2006). The results indicated that the positive results of the COVID-19 pandemic were related to higher education. Participants often mentioned working from home as a positive consequence of a pandemic. The reasons may be a shortening of commuting time (less traffic jams), better perceived control and independence, greater efficiency or more time with family and loved ones.

Methodology

Participants and procedure

The research group consisted of 95 students of the Faculty of Sports of the University of Prešov in Prešov (men: n = 62, women: n = 33) with average age 22 +/- 6 years. Fifty of all students studied in the first (bachelor) degree and 45 students in the second (master) degree. Due to the extraordinary pandemic situation and the limitation of social contact, the only way we could continue the research was an online questionnaire. We created the questionnaire via the Google Forms platform and distributed it to students of the Faculty of Sports electronically. Students had time to complete the questionnaire from 17. 11. 2021 to 19. 11. 2021.

Questionnaire WHOQOL-BREF

The WHOQOL-BREF standardized questionnaire from the World Health Organization was used as a research tool. The WHOQOL-BREF questionnaire consist of 26 items, of which twenty-four represent individual aspects and two items are separate assessments of overall quality of life and overall health. This questionnaire focuses on the self-assessment of an individual's quality of life. We selected two domains for needs of our research– Psychological health and Social Relationships. Our modified WHOQOL-BREF questionnaire represents a selection of 9 items, six of which represent psychological health: (1) enjoyment of life, (2) meaning of life, (3) concentration, (4) acceptance of physical appearance, (5) satisfaction with

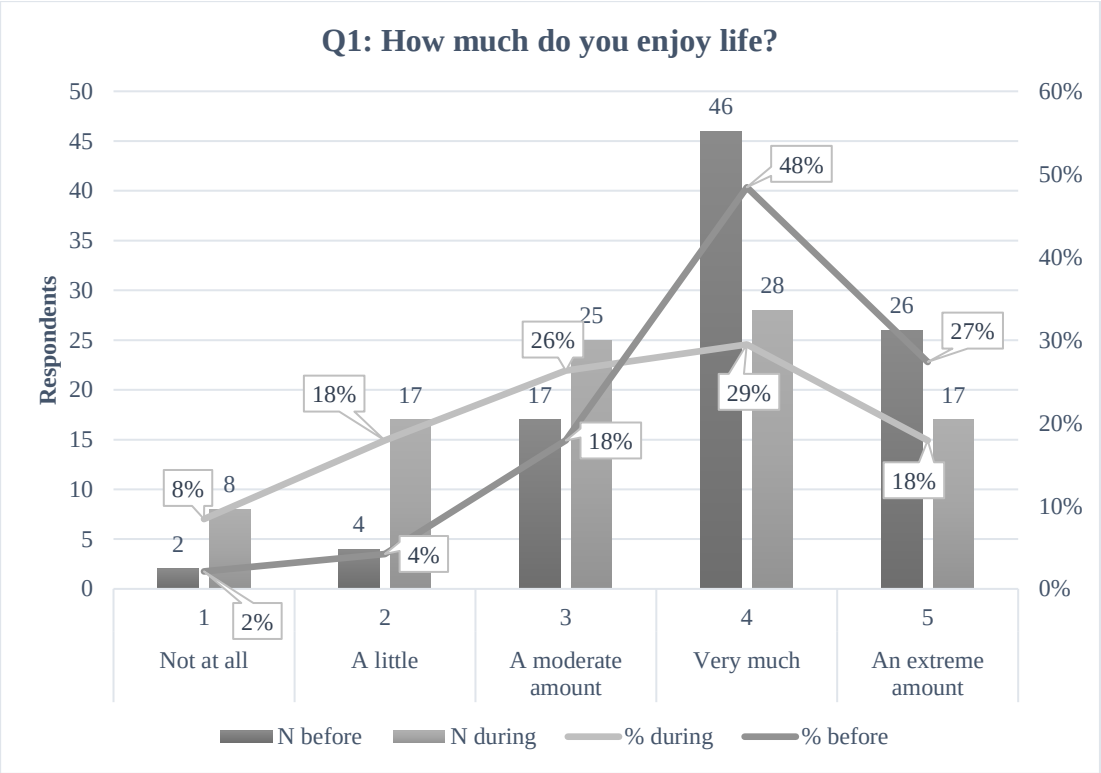
oneself, (6) negative feelings and three represent social relationships: (7) personal relationships, (8) sexual activity, (9) social support. We modified the original questionnaire for better evaluation of the mental health and social relationships of university students before COVID-19 pandemic, when students considered the questions retrospectively and during the COVID-19 pandemic, to find a change in university students' subjective perceptions due to pandemic situation and limited arrangement. Responses to questions are on a 1-5 Likert scale where 1 represents "disagree" or "not at all" and 5 represents "completely agree" or "extremely". WHOQOL-BREF has been validated for a healthy population and for patients with various types of somatic and mental disorders (Dragomirecká & Bartoňová 2006).

Data analyses

We processed the data from the questionnaire using mathematical-statistical methods using the statistical program Statistica (version 13.5). Due to multiciplity we used in the research group the Kolmogorov-Smirnov test to evaluate the normal distribution of data. We used the median and mode for the position characteristics and the maximum and minimum for the variance characteristics. At the earliest, we determined statistical significance between data from period before and during COVID-19 pandemic using the Wilcoxon paired t test. Subsequently, we recorded the differences using a graph, which we used Microsoft Office Excel and we also described them in writing.

Results

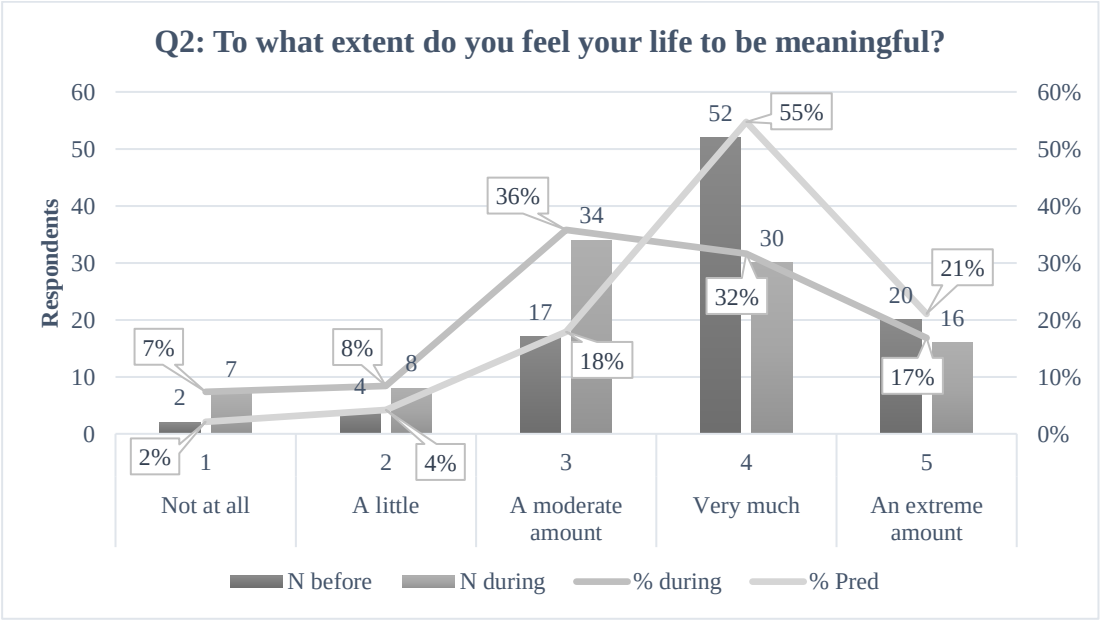
The results are compared to the period before and during the Coronacrisis. An interesting but logical finding is that university students enjoyed life less after the outbreak of the COVID-19 pandemic, than before (Figure 1). The answer "An extreme amount" was marked by 26 university students before and 17 university students after the outbreak of the pandemic, which is a decrease of 9 %. In the answer "Very much" is difference even more noticeable by 19 %, 46 university students marked this answer before the pandemic, but only 28 university students during the pandemic. On the other hand, the number of university students who enjoyed life only "a little" increased from 4 university students to 17, which represents a 14 % increase. We found statistically significant differences between the periods before and during the coronarisis ($p = 0.000007$). During the COVID-19 pandemic 46 % of university students enjoyed life less, 41 % of university students feels the same as before the Coronacrisis, and only 13 % of respondents enjoyed life more than before COVID-19 pandemic.



Abbreviations: *N before, number of respondents before COVID-19 pandemic; N during, number of respondents during COVID-19 pandemic; % during, percentage representation of respondents during COVID-19 pandemic; % before, percentage representation of respondents before COVID-19 pandemic*

Figure 1

Responses to Q1: How much do you enjoy life?

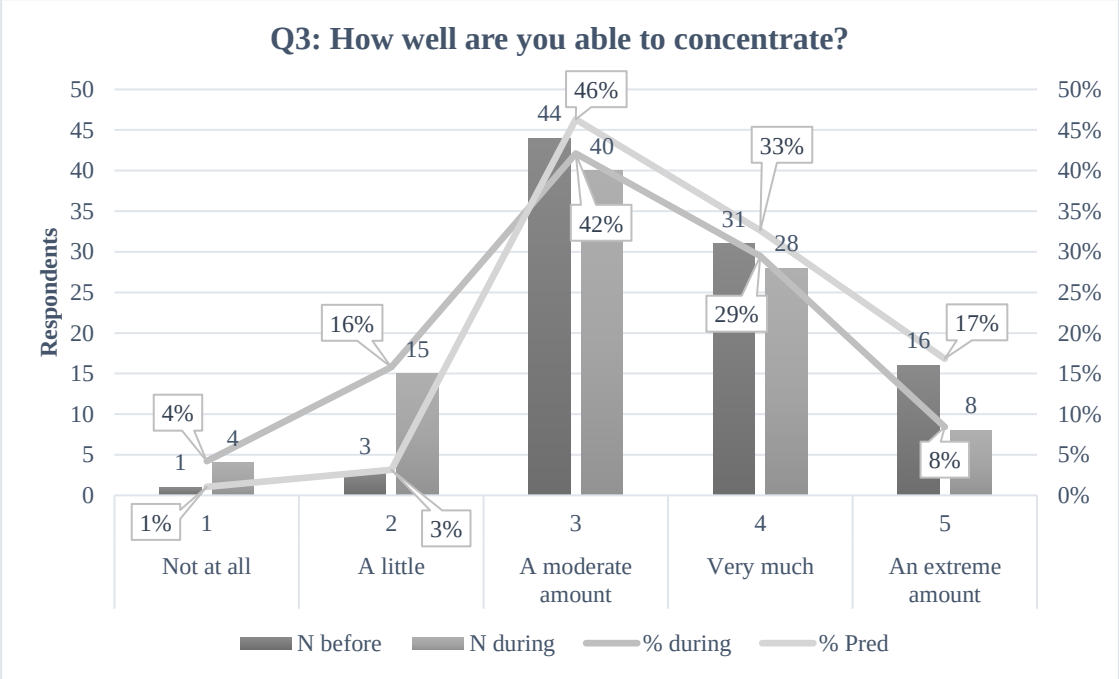


Abbreviations: *N before, number of respondents before COVID-19 pandemic; N during, number of respondents during COVID-19 pandemic; % during, percentage representation of respondents during COVID-19 pandemic; % before, percentage representation of respondents before COVID-19 pandemic*

Figure 2

Responses to Q2: To what extent do you feel your life to be meaningful?

We found that the most common answer of university students to question Q2 was the answer „Very much“ (55 %) in the period before the Coronacrisis, but during the Coronacrisis it was answer „A moderate amount“ (36 %) (Figure 2). During the Coronacrisis the answer „Very much“ decreased by 23 %. On the other hand, we found a significant increase of 18 % in the answer "Average", which was marked before the pandemic by 17 and during 34 university students. We found statistically significant differences (p = 0.000281) compared to the period before and during the Coronacrisis. We found that 52 % of university students considered their lives to be as meaningful during the Coronacrisis same as before the outbreak. 40 % of students felt that their lives were less meaningful during the COVID-19 pandemic, and only 8 % of students said that they subjectively perceived their lives more meaningful during the Coronacrisis.

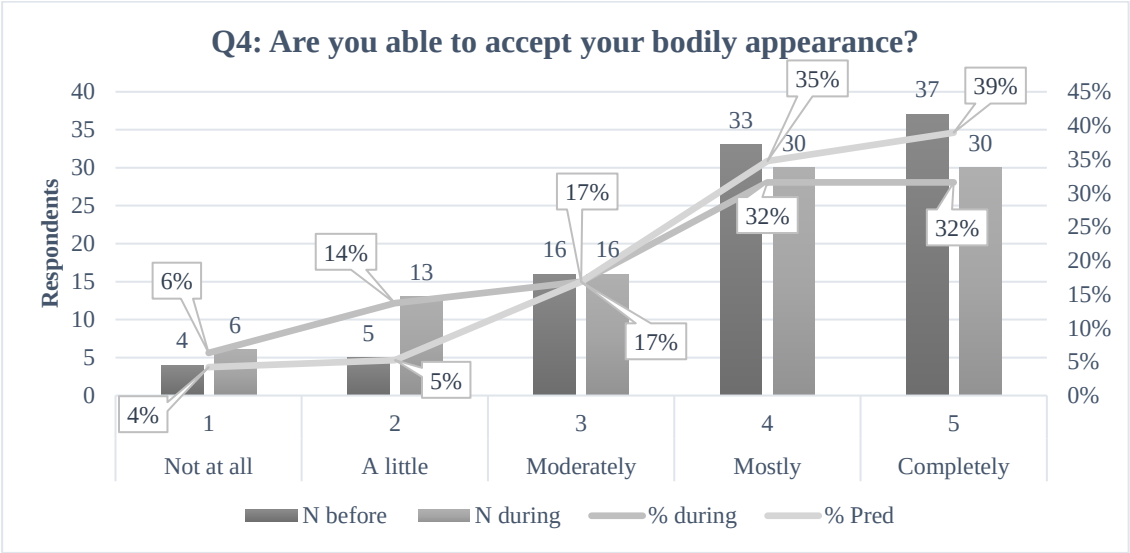


Abbreviations: *N before, number of respondents before COVID-19 pandemic; N during, number of respondents during COVID-19 pandemic; % during, percentage representation of respondents during COVID-19 pandemic; % before, percentage representation of respondents before COVID-19 pandemic*

Figure 3
Responses to Q3: How well are you able to concentrate?

We compared Q3 between the period before a during coronacrisis (Figure 3). "An extreme amount" of concentration decreased by 9 % among university students. On the other hand, the answer "A little" was marked by 3 university students before and 15 university students during the Coronacrisis, which represents a 13 % increase. The most frequent response was „A moderate amount“, 44 students before and 40 students during the Coronacrisis. Based

on our results, we can conclude that the concentration of university students was not greatly affected by the COVID-19 pandemic. The majority of students (58 %) felt the same ability to concentrate during the Coronacrisis, and 11 % of students felt they were better concentrated during the COVID-19 pandemic than before the outbreak. 1/3 of respondents (38 %) felt worse in concentration during the Coronacrisis.



Abbreviations: *N before, number of respondents before COVID-19 pandemic; N during, number of respondents during COVID-19 pandemic; % during, percentage representation of respondents during COVID-19 pandemic; % before, percentage representation of respondents before COVID-19 pandemic*

Figure 4
Responses to Q4: Are you able to accept your bodily appearance?

The most common answer to Q4 (Figure 4) was before COVID-19 pandemic "Completely" (39 %). During the coronarisis, the most frequent answers from students were "Completely" and "Mostly" (both 32 %). We found a statistically significant difference ($p = 0.014257$) how university students are able to assume their body appearance in the period before and during the Coronacrisis. 16 % university students during the Coronacrisis managed their free time very well as they were able to better accept their body appearance. 28 % of university students perceived their body appearance worse after the outbreak of the COVID-19 pandemic, and 56% of students did not see a difference in the perception of their body appearance compared to the period before and during the Coronacrisis.

In the next question Q5*: How satisfied are you with yourself* in the period before and during the Coronacrisis? We observe a slight decrease in the positive answers "Satisfied" by 10 % and "Very satisfied" by 7 %. On the other hand, we observe an increase in the more negative answers "Dissatisfied" by 8 % and "Very dissatisfied" by 6 %.

Abbreviations: *N before, number of respondents before COVID-19 pandemic; N during, number of respondents during COVID-19 pandemic; % during, percentage representation of respondents during COVID-19 pandemic; % before, percentage representation of respondents before COVID-19 pandemic*

Figure 5

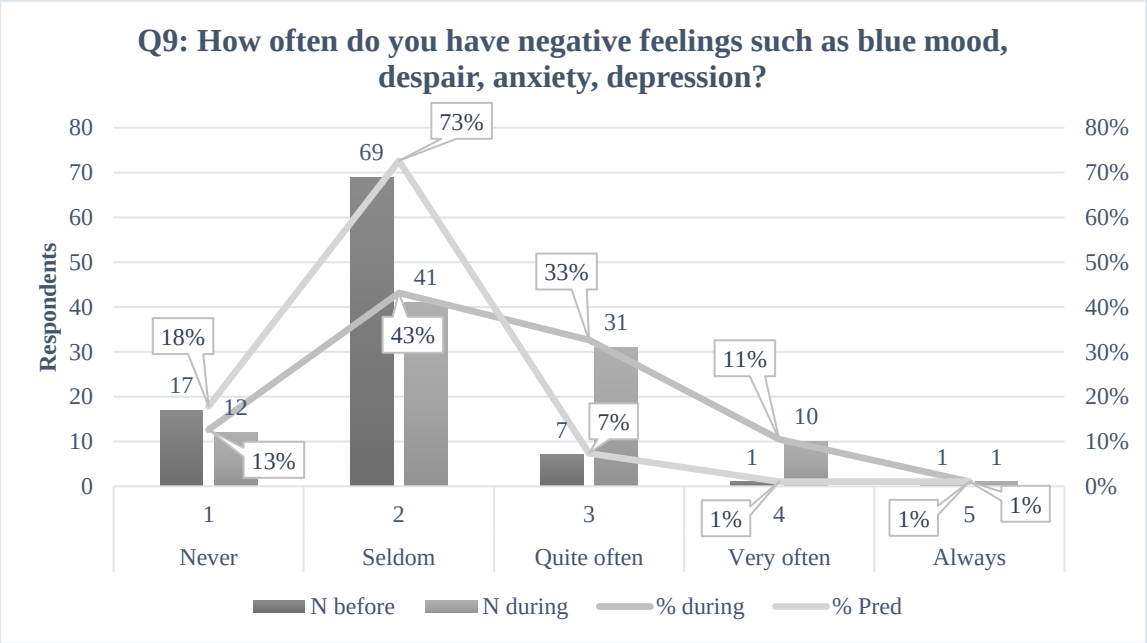
Responses to Q6: How satisfied are you with your personal relationships?

We observe a decrease in very satisfied students by 14 % (Figure 5). Contrariwise, the number of dissatisfied students increased by 10 %. We found a statistically significant difference between the periods before and during the Coronacrisis (p = 0.00051) in satisfaction with the personal relationships of university students. Due to social distance and restrictive measures we assume that 43 % of university students were less satisfied with personal relationships during the COVID-19 pandemic than before the outbreak. 16 % of students experienced an improvement in this field and 41 % of university students did not notice any changes in satisfaction with personal relationships during the Coronacrisis.

Question Q7: *How satisfied are you with your sex life*? We observe that 13 % of university students were very disappointed with their sex life during the Coronacrisis. We found statistically significant differences in the question Q7 *(p = 0.000116)*, in which we also see a decrease in very satisfied students by 10 % in the period during the Coronacrisis. Up to 61 % of university students felt the same satisfaction with their sex life as before the outbreak of the pandemic, and only 8 % saw an improvement in this field. 31 % of university students were more dissatisfied with their sex life during the Coronacrisis.

*W*e asked college students *how satisfied they were with the support they received from their friends* (question 8). The most common answer to th*is question was* "Satisfied", it was marked by 44 % students in the period before and 38% students in the period during the Coronacrisis. The second most common response was "very satisfied", which was marked before the pandemic by 29 % students and during 22 % of university students. We found

statistically significant differences *(p = 0.000939)* how satisfied university students were with support from their friends.



Abbreviations: *N before, number of respondents before COVID-19 pandemic; N during, number of respondents during COVID-19 pandemic; % during, percentage representation of respondents during COVID-19 pandemic; % before, percentage representation of respondents before COVID-19 pandemic*

Figure 6

Responses to Q9: How often do you have negative feelings such as blue mood, despair, anxiety, depression?

Our last question in the WHOQOL-BREF questionnaire was very interesting. We asked about the period before and during the Coronacrisis. We can see (Figure 6) a 10 % increase in the answer "Very often" and a 26 % increase in the answer "Quite often". The number of university students who experienced these negative feelings "Seldom" decreased by 30 %, which is another negative effect we noticed during the Coronacrisis. We found a statistically significant differences in the perception of negative feelings such as bad mood, despair, anxiety or depression (p = 0.000008). Approximately half of the students (54 %) had negative feelings, such as bad mood, despair, anxiety or depression, both before and during the Coronacrisis. 42 % of students had these feelings subjectively more frequently during the COVID-19 pandemic, and only 4 % of students felt better about negative feelings.

Discussion

Due to the pandemic situation, more than 1.7 million students worldwide have dropped out of education. Schools and universities have not experienced this level of disruption since

World War II (Dietrich et al. 2020). Living conditions and opportunities have changed from day to day and, just like all people, university students have had to adapt to these changes and get used to it quickly. For this reason, in our research, we focused on the psychological health and social relationships of university students in the period before and during the COVID-19 pandemic.

The results of our study indicate that the COVID-19 pandemic has a negative impact on the psychological health and social relationships of university students. Nearly half of the students enjoyed life less and felt that their lives were less meaningful during the COVID-19 pandemic. The concentration of university students was not affected by the COVID-19 pandemic, as more than half of the students felt the same ability to concentrate during and before the Coronacrisis. We determined a statistically significant difference in how university students are able to accept their body appearance in the period before and during the Coronacrisis. Almost half of the students subjectively changed their view of their body appearance during the pandemic. Due to social distance and limited arrangement, almost half of the university students were less satisfied with their personal relationships during the COVID-19 pandemic than before the outbreak. We experienced the same satisfaction with their sex life during the COVID-19 pandemic as before the outbreak in more than half of the students. In the domain of social relations, we found statistically significant changes in how satisfied university students were with support from their friends. Almost half of the students had negative feelings such as bad mood, despair, anxiety or depression more often during the COVID-19 pandemic than before the outbreak. It is necessary to find out how a pandemic also secondarily affects the mental health or social relations of students, so that we can be better prepared for similar situations in the future.

Conclusions

Based on our results, we recommend monitoring the mental health of university students, raising awareness of various media platforms about psychological problems during a pandemic, and emphasize the importance of seeking help and engaging in physical activity in managing mental health disorders. We also recommend involving psychological counselors in the educational process at universities, who would be available to students, mainly in such rapidly changed conditions as we experienced during the outbreak of the COVID-19 pandemic.

References

1. AL DHAHERI, A. S. et al., 2021. Impact of COVID-19 on mental health and quality of life: Is there any effect? A cross-sectional study of the MENA region. In: *PLOS ONE.* **16**(3): e0249107. https://doi.org/10.1371/journal.pone.0249107.
2. ALVAREZ, F., D. ARGENTE & F. LIPPI, 2020. A simple planning problem for COVID-19 lockdown. In: *NBER Working Papers 26981*, National Bureau of Economic Research, Inc.
3. CAM, H. H. et al., 2021. Impact of the COVID-19 pandemic on mental health and health-related quality of life among university students in Turkey. In: *Current Psychology*. https://doi.org/10.1007/s12144-021-01674-y.
4. CAO, W. et al., 2020. The psychological impact of the COVID-19 epidemic on college students in China. In: *Psychiatry Research*. č. 287, 112934.
5. CHENG, C. et al., 2006. Perception of benefits and costs during SARS outbreak: An 18-month prospective study. In: *Journal of Consulting and Clinical Psychology*. **74**(5), 870–879. doi:10.1037/0022-006x.74.5.870.
6. DIETRICH, N. et al., 2020. Attempts, Successes, and Failures of Distance Learning in the Time of COVID-19. In*: Journal of Chemical Education.* doi:10.1021/acs.jchemed.0c00717.
7. DRAGOMIRECKÁ, E. 2006. Česká verze dotazníku kvality života WHOQOL. Překlad položek a konstrukce škál. In: *Psychiatrie.* **10**(2).
8. GIJZEN, M. et al., 2020. The Bittersweet Effects of COVID-19 on Mental Health: Results of an Online Survey among a Sample of the Dutch Population Five Weeks after Relaxation of Lockdown Restrictions. In: *International Journal of Environmental Research and Public Health.* **17**(23), 9073. doi:10.3390/ijerph17239073.
9. GRAJEK, M. & K. SOBCZYK, 2021. Well-being levels among students during the COVID-19 pandemic. In: *Journal of Physical Education and Sport*. **21(**4), s. 1682-1687. ISSN 2247-8051.
10. LI, L. Z. & S. WANG, 2020. Prevalence and predictors of general psychiatric disorders and loneliness during COVID-19 in the United Kingdom. In: *Psychiatry Research*. č.291, 113267.
11. MOGHANIBASHI-MANSOURIEH, A., 2020. Assessing the anxiety level of Iranian general population during COVID19 outbreak. In: *Asian Journal of Psychiatry*. **51**.

12. OEGILÉS, M., et al., 2020. Immediate psychological effects of the COVID-19 quarantine in youth from Italy and Spain. In: *Psychological Medicine*. s. 1-6.
13. PARK, K. H. et al., 2021. Impact of the COVID-19 pandemic on the lifestyle, mental health, and quality of life of adults in South Korea. In: *PLoS ONE*. **16**(2): e0247970. https://doi.org/10.1371/journal.pone.0247970
14. QANASH, S. et al., 2020. Psychological Effects on Health Science Students After Implementation of COVID-19 Quarantine and Distance Learning in Saudi Arabia. In: *Cureus*. **12**(11), e11767.
15. QIU J. et al., 2020. A Nationwide Survey of Psychological Distress Among Chinese People in the COVID-19 Epidemic: Implications and Policy Recommendations. In: *General Psychiatry*. **33**(2), s. 1-3.
16. SZCZEPAŃSKA, A. & K. PIETRZYKA, 2021. The COVID-19 epidemic in Poland and its influence on the quality of life of university students (young adults) in the context of restricted access to public spaces. In: *J Public Health.* (Berl.). https://doi.org/10.1007/s10389-020-01456-z
17. ZANDIFAR A. & R. BADRFAM, 2020. Iranian mental health during the COVID-19 epidemic. In: *Asian Journal of Psychiatry*. Roč. **51**.
18. ZHANG, C. et al., 2020. The Psychological Impact of the COVID-19 Pandemic on Teenagers in China. In: *Journal of Adolescent Health*. **67**(6), s. 747-755. https://dx.doi.org/10.1016%2Fj.jadohealth.2020.08.026

DOI 10.2478/afepuc-2022-0006
© Acta Facultatis Educationis Physicae Universitatis Comenianae 2022, 62(1): 53-71

ANALYSIS OF THE PROFESSIONAL COMPETENCY INDICATORS OF UNIVERSITY PHYSICAL TRAINER STUDENTS

Othman Benbernou[1-2], Fatima Bennama[1-2], Adel Belkadi[1], Sedik Boukchiche[1-2], Sid Mohamed Koutchouk[1-2]

[1] University of Mostaganem, Institute of Physical Education and Sport,Mostaganem, Algeria
[2]Training-University Research Projects (PRFU N° J00L02UN270120200001 Agreement: January 2020), 16000 Algeria

Summary: Objective: The main purpose of this study was to analyse the indicators of the professional Competency of University physical Trainer students, and to explore the importance of these professional indicators. By referring to the two international physical fitness education institutions and literature reviews, three important perspectives of professional Competences are: Professional knowledge, Professional skills, Professional attitude, Furthermore, the result of this research was concluded after three integration of opinions. **Method** : Delphi technique was used to integrate the opinions of fifty-two experts and scholars, and the research results were obtained after three integrations. Among the 52 indicators at the three levels. **Result**: experts agree that professional attitude is the most important. followed by professional skills, and then professional knowledge. the professional attitude level, "maintaining a positive and enthusiastic professional attitude" was the most important indicator. In the professional skills level, it was noted that "physical fitness training cycle plan design ability", "physical fitness action correction ability", "emergency intervention" Ability to adapt" and "ability to use and demonstrate sports equipment" are the most important indicators. In terms of professional knowledge, "customer sports curriculum design" is the most important. **Conclusion**: this research can provide references for the university in future development of physical trainer's training program and establish regulations; fitness club hiring process; self-growth in the industry; future researches and studies.

Key words: personal fitness trainer, professional competence, index construction, Delphi technique.

Introduction

With the rise of Algerian people's concept of fitness and health care, various clubs and gym-related industries are also successful (Doğan 2015). Attached with the promotion of government policies, physical fitness education has been combined with national sports (Pratt et al. 2015). Therefore, a large number of public sports centres, large chain gyms, and individual sports studios have been established high demand needs (Hums, Barr, Gullion 1999; Rafoss, Troelsen 2010). As far as the fitness industry is concerned, personal fitness coaches are fitness instructors who are in contact with the public on the front line (Orfaly et al. 2005; Kranz et al. 2013), providing the public with personalized and professional fitness consultation and course planning (Organization, Ageing, Unit 2008; Yang & Chen 2022), teaching one-to-one courses, and selling and executing their related administration (Luo, Wang, Tai 2019). Work with management and assist clients in the proper use of fitness equipment to effectively achieve personal fitness goals (Seeman,O'Hara 2006; Thompson 2015). The achievement of these duties must be provided through the professional knowledge of the coaches themselves (Abraham, Collins, Martindale 2006; Ladyshewsky 2010).

Therefore, it is very important to clients and a certain degree to health influence, and determines the development of students' sports concepts and the intention of participating in sports courses, thereby improving the Physical fitness and improve the quality of life (Piercy et al. 2018; Malm, Jakobsson, Isaksson 2019). To be a competent individual fitness coach, one must meet the special needs of the fitness profession (Astin 1984).

Personal fitness coaches have always been referred to fitness coaches, club fitness instructors or sports coaches for the reason that the professionalism of the industry has not yet been really defined (Smith Maguire 2008). Belkadi (2015) pointed out that a personal fitness coach is an advanced position for a fitness coach and content of their work are created by the sport industry in response to market demand.

This study emphasizes that personal physical Trainer students need to pass the examination and examination of professional institutions and have the competency to provide practical guidance of personal fitness courses for clients. In addition, scholars such as (Kirschner, Van Vilsteren, Hummel, Wigman 1997) believe that they must have three majors: professional knowledge, professional skills and professional attitude In the guidance of physical fitness, in addition to the skills of general physical fitness training.

Kunter (2013) believed that professional competence should include three elements: professional knowledge, professional skills and professional attitude (Epstein Hundert 2002;

Kunter et al. 2013). Professional knowledge refers to the facts, data and knowledge that professionals need in their daily work to efficiently and effectively promote the achievement of a certain function (Cushion, Armour, Jones 2003; Santos, Mesquita, GRAÇA, Rosado 2010; Adel, Mohammed 2017). Knowledge-level competencies are easier to measure and are most emphasized in traditional professional training, and as a matter of fact, knowledge is considered a sufficient condition for actual performance (Lilly 1979; Belkadi et al. 2015). Secondly, (Bloom 1997; Lyle 2002). The professionalism of skills can be assessed from actual performance or a specific effect (Van Der Vleuten 1996; Kunter et al. 2013). As for professional attitude, it refers to an emotional avoidance effect. Attitude can often be measured by observing someone's behavior or from conversations. Although attitude is more difficult to measure, it should not be ignored (Parle, Maguire, Heaven 1997).

According to Belkadi's (2015) definition, professional competence refers to the professional knowledge, professional skills and professional attitude that practitioners need to have in order to successfully play the role and perform their functions at work, and be competent for the work they are engaged in. This study refers to the emphasis placed on professional knowledge, professional skills and professional attitude as a personal fitness coach, because it exceeds the professional needs and job needs of general fitness instructors.

Hughes (2022) believes that an “indicator” refers to the change of a certain variable over time and region relative to the base period. It is a statistical measurement, which can reflect the main phenomenon of important levels, and can aggregate and differentiate related levels to achieve the purpose of research and analysis (Hughes, Bartlett 2002). Liakopoulou (2011) believes that the ability index is a statistical quantity used to describe or reflect the knowledge, skills and attitudes possessed by competent work, and is a concept, description or response to the knowledge, skills and attitudes necessary to be competent for a certain job (Liakopoulou 2011). The competency indicators referred in this study to the knowledge, skills and attitudes that individual fitness coaches should have in the workplace.

In view of this, this research will use surveys to understand the development status of personal fitness coaches in Algeria, with reference to the American Association of Sports Medicine (ACSM) Certified Personal Trainer (CPT), the American Aerobic Fitness Association (AFAA) Personal Fitness Trainer (PFT) The learning structure of the two-institution certification examination, to discuss the professional Competency and needs analysis of the personal fitness trainer.

According to the research idea and research background, the purpose of this research is

to set two goals: The first goal Construct the professional Competency index of individual University physical Trainer students. The second goal Establish the importance level of the professional Competency index of individual physical fitness coaches.

Material & methods

Participants

This research adopted a mixed qualitative and quantitative research method, and took fifty tow university teachers from Physical Education and sport institutes and participating in sports as experts, all participants experts sign consent form and agree to participate in this research project as the research subjects, Dalkcy (1969) believed that if the Delphi group had at least 10 experts subjects, the error of the group can be minimized, and the reliability of the group is the highest. This also served as the basis for the quantitative consideration when setting up the Delphi team members.

Objects related to the practice of Delphi technique considered that respondents must possess the following four characteristics:

1. Have an in-depth overview of the problem.
2. Have a wealth of information to share with others.
3. Enthusiasm to participate in the work of Delphi.
4. It is believed that the group's judgment results will contain information's that is personally valued by the group.

Methods /Research tool

The method of selecting experts for this research mainly takes scholars or experts from the relevant academic and practical fields as the survey objects, who can put forward opinions and predictions on the problem with their rich professional knowledge or practice. Scholars related to physical fitness education (academia) and people with practical experience (sports agencies) will be included as the research objects of the above three round of the survey.

"Delphi" is a method of group determination. It uses surveys (Hasson, Keeney, McKenna 2000), Traditional surveys only need to implement one survey to complete the investigation; however, *Delphi* requires a series of intensive, and its research cannot be completed until the survey items reach consistency. Delphi provides multiple feedbacks and has the communication function of a meeting.

In this study was established the professional Competency index of physical Trainer students as the research object, and seek the consensus of the expert group, and therefore the

distribution of the research survey, the three foundations of natural virtue wisdom include structured information flow, anonymous group decision and expert judgment. In the application of technology, a survey is designed for a certain topic, a group of experts are invited to express their opinions, and then collected and organized, in order to obtain the common opinion of the group members (Avella 2016). According to Gnatzy's (2011) research, Delphi's survey distribution is basically a "repetitive" survey using a continuous "structured" survey. The purpose is to extensively collect data as the basis for designing the second survey Of course, the first survey can also be designed by the researcher according to the relevant literature (Gnatzy, Warth, von der Gracht, Darkow 2011). The survey after the second time is revised according to the answering situation of the previous survey. This research has adopted moral skills and expected that enterprises will construct the index construction of the professional Competency of individual physical fitness coaches, and design appropriate research tools by referring to the existing examination subjects related to physical fitness coaches.

The first survey design

The survey design was divided into three dimensions: professional knowledge, professional attitude and professional skills. The design of the subject is explained as follows:

- Survey on the "professional knowledge" level of the research on the construction of professional Competency indicators for physical fitness personal coaches, Basically integrating ASCM Subject to the AFAA Personal Fitness Test.
- Survey on the "professional attitude" level of the research on the construction of professional Competency indicators of physical fitness personal coaches, Basically integrating ASCM With AFAA personal fitness textbook subjects and the author's personal opinion.
- Survey on the "professional skills" level of the research on the construction of professional Competency indicators for physical fitness personal coaches, Basically integration and ASCM Exam subjects with the AFAA Personal Fitness Instructor. The survey was divided into four parts, the first part is the basic information, and the other three surveys are three levels of "professional knowledge ", "professional skills" and "professional attitude".

The second survey design

The researcher compiles the second survey according to the results of the first survey. If the original opinion is maintained without filling out the answer form, if the opinions adjusted by the experts are quite different from the opinions of most experts, the reasons should be explained for the convenience of research and reference. The third survey of this research is

based on the second recovery of the Delphi technique survey. After integrating the data, this survey is based on the percentage of opinions of the expert members on each evaluation index and the "agreement degree" of the "new items". And "Importance" percentage, presented in this survey.

Statistical analyses

The main analysis method of the data collected by Delphi is the method of collecting both quality and quantity. For written comments, content analysis method was adopted to summarize or aggregate the opinions of respondents. If two or more people have the same opinion, they should add the number of times to indicate their strength; the average can also be taken. The larger the average, the greater the relative importance. For the evaluation of each question, the analysis of the amount of concentration and the amount of variation is carried out. This research is an indicator for constructing the professional ability of individual physical Trainer students. After collecting opinions and data from the expert group with Delphi's technique, data analysis is carried out. According to the survey design, it is found that:

1. Indicates the expert members' perception of the importance of the construction and evaluation of the physical Trainer student's professional ability index.
2. This research will be divided into three aspects: "professional knowledge", "professional skills" and "professional attitude" according to the average, and they are sorted according to the importance level.
3. In the aspect of importance judgment, this study adopted a Likert scale, which consists of a set of statements, each statement has the "strongly agree ", "agree", "not necessarily", "disagree agree", " strongly disagree «, The five answers of "strongly disagree" are recorded as 1, 2, 3, 4, and 5.

The total score of each respondent's attitude is the sum of the scores of his answers to each question. The total score can indicate that the respondents attitude strength or its different status on this scale.

Results

After three rounds of Delphi's survey, the opinions of experts on the professional ability indicators of physical fitness coaches were collected, and the professional ability indicators of individual physical fitness coaches were summarized Table 1.

Analysis of the results of the first round of Delphi's Survey; Section 2 Analysis of the

results of the second round of Delphi's Survey; Section 3 Analysis of the results of the third round of Delphi's Survey; The fourth section discusses the comprehensive results. The purpose of this section is to explain the first round of the Delphi Technique survey, how to summarize and organize the surveys after recovery, to collect the opinions of experts on the professional ability indicators of fitness coaches, and to understand the consensus process of the expert members on the evaluation indicators. The opinion of the degree, importance level, and whether the expert members think there are other indicators that should be included, as the basis for designing the second round of the survey. Table 1 It is the time of sending and returning the surveys for the first time by Delphi experts. This section is divided into three parts: 1. Professional knowledge 2. Professional attitude 3. Professional skills.

Table 1

The results and analysis Number of experts for the 3 round of surveys

Number of expert	**Number of copies sent**	**Recycled copies**	**Valid survey**	**Valid survey recovery rate (%)**
52	52	52	52	100

Table 2

The results of the first Delphi technique expert survey (professional knowledge)

Expertise Indicators	**Importance**		**Consistency**	
	Median	Average	Rank	Agree rate (%)
1. Career development in the fitness industry	4	4.20	7	80
2. How to conduct personal training sessions based on education	4	4.20	7	90
3. How to establish personal fitness education based on education Practicing relationship with clients	5	4.60	4	90
4. Understand the future development direction of personal fitness coaching	4	4.20	7	80
5. Exercise Physiology	5	4.70	3	100
6. Anatomy, Kinesiology and Biomechanics	5	4.80	2	100
7. Learning motor skills	5	4.80	2	100
8. Pedagogy and Client Learning Courses	4	4.30	6	100
9. Sports Psychology, Motivation and Behavior Change	4	4.30	6	100
10. Nutrition	4.5	4.30	6	100
11. Customer initial consultation	5	4.60	4	80
12. Objective goal setting between client and individual fitness coach determination and method	4.5	4.40	5	100
13. Risk screening and classification	5	4.70	3	100
14. Customer health and fitness testing	5	4.60	4	100
15. Client exercise course design	5	4.90	1	100
16. resistance training schedule	5	4.80	2	100
17. Cardio training schedule	5	4.80	2	100
18. Design Flexibility Schedule Policy	5	4.70	3	90
19. Sequence of personal training schedules	5	4.70	3	100
20. Business Fundamentals and Planning	4	3.70	8	80
21. Legal Terms and Liability	4	4.30	6	100

Table 3

The results of the first Delphi technique expert survey (professional attitude)

	Importance		**Consistency**	
Expertise Indicator	Median	Average	Rank	Consent Rate (%)
1. Continue to absorb and learn sports science information	5	4.80	3	100
2. Respect customer privacy	5	4.90	2	100
3. Set career development goals	5	4.60	5	100
4. Good time management	5	4.90	2	100
5. Maintain a positive and enthusiastic professional attitude	5	5.00	1	100
6. Excellent customer service and attention program	5	4.70	4	100
7. Maintain good communication and listening with customers	5	4.90	2	100
8. High EQ with empathy	5	4.90	2	100
9. Give customers training autonomy	5	4.60	5	100
10. Stay in touch with other health experts	5	4.60	5	100

Table 4

The results of the first Delphi technique expert survey (professional skills)

Expertise Indicators	**Importance**		**Consistency**	
	Median	Average	Rank	Agree rate (%)
1. Physical fitness test execution and demonstration ability	5	4.70	3	100
2. Ability to interpret physical fitness test results	5	4.80	2	100
3. Physical fitness training cycle plan design ability	5	4.90	1	100
4. Physical fitness training exercise demonstration ability	5	4.80	2	100
5. Physical fitness training program record ability	5	4.80	2	100
6. Physical fitness action correction ability	5	4.90	1	100
7. Sports injury assessment and protection ability	4	4.30	5	100
8. Ability to respond to emergencies	5	4.90	1	100
9. Ability to lead customer behaviour change	5	4.60	4	100
10. Ability to use social media	4	4.00	6	90
11. Ability to plan and direct group lessons	4	3.80	7	90
12. Ability to use computer word processing	4	3.80	7	100

Table 5

Results of the 1st Delphi's Expert Survey (all levels)

Importance		
Expertise Indicators	Average	Rank
professional knowledge	4.50	3
professional attitude	4.79	1
professional skill	4.53	2

Analysis of the results of the second round of Delphi's survey

The purpose of this section is to explain the second round of the Delphi Technique questionnaire, how to summarize and organize the questionnaires after the questionnaires are collected, collect the opinions of the experts on the professional ability indicators of fitness

coaches, and understand the consensus process of the expert members on the evaluation indicators. Opinions on the degree and importance level of the expert members, and whether the expert members adjust the importance level opinions of each evaluation target after referring to the distribution percentages of the importance levels of other expert members and also understand the degree of agreement and importance level of the expert members on the newly added evaluation index items, as the basis for designing the third round of questionnaires.

Table 6

Results of the second Delphi technique expert questionnaire (professional knowledge)

Expertise Indicators	**Importance**		**Consistency**	
	Median	Average	Rank	Rate (%)
1. Career development in the fitness industry	4.20	7	4	80
2. How to conduct a personal training session based on education	4.20	7	4	90
3. How to establish personal fitness education based on education Practicing relationship with clients	4.60	4	1	90
4. Understand the future development direction of personal fitness coaching	4.20	7	4	80
5. Exercise Physiology	5	4.70	3	100
6. Anatomy, Kinesiology and Biomechanics	5	4.80	2	100
7. Learning motor skills	5	4.80	2	100
8. Pedagogy and Client Learning Courses	4	4.30	6	100
9. Sports Psychology, Motivation and Behavior Change	4	4.40	5	100
10. Nutrition	4.5	4.40	5	100
11. Customer initial consultation	5	4.70	3	80
12. Objective goal setting between client and individual fitness coach determination and method	4.5	4.40	5	100
13. Risk Screening and Classification	5	4.70	3	100
14. Customer health and fitness testing	5	4.60	4	100
15. Client exercise course design	5	4.90	1	100
16. resistance training schedule	5	4.80	2	100
17. Cardio training schedule	5	4.80	2	100
18. Design Flexibility Schedule Policy	5	4.70	3	90
19. Sequence of personal training schedules	5	4.70	3	100
20. Business Fundamentals and Planning	4	3.70	10	80
21. Legal Terms and Liability	4	4.20	7	100
22. Sports injury protection and health care	4	4.10	8	100
23. sports medicine	4	3.90	9	90
24. sports coaching	3	3.70	10	80
25. sports training	4	4.10	8	100
26. Sports Program Administration and Management	3	3.40	11	80

Table 7

Results of the second Delphi technique expert questionnaire (professional attitude)

Expertise Indicators	**Importance**		**Consistency**	
	Median	Average	Rank	Agree rate (%)
1. Continue to absorb and learn sports science information	5	4.80	3	100
2. Respect customer privacy	5	4.90	2	100
3. Set career development goals	5	4.60	5	100
4. Good time management	5	4.90	2	100
5. Maintain a positive and enthusiastic professional attitude	5	5.00	1	100
6. Excellent customer service and attention program	5	4.70	4	100
7. Maintain good communication and listening with customers	5	4.90	2	100
8. High EQ and Empathy	5	4.90	2	100
9. Give customers training autonomy	5	4.60	5	100
10. Stay in touch with other health experts	5	4.60	5	100
11. Self-maintaining good posture and lifestyle	4.5	4.50	6	100

Table 8

Results of the second Delphi technique expert questionnaire (professional skills)

Expertise Indicators		**Importance**		**Consistency**
	Median	Average	Rank	Agree rate (%)
1. Physical fitness test execution and demonstration ability	5	4.70	3	100
2. Ability to interpret physical fitness test results	5	4.80	2	100
3. Physical fitness training cycle plan design ability	5	4.90	1	100
4. Physical fitness training exercise demonstration ability	5	4.80	2	100
5. Physical fitness training program record ability	5	4.80	2	100
6. Physical fitness action correction ability	5	4.90	1	100
7. Sports injury assessment and protection ability	4	4.20	5	100
8. Ability to respond to emergencies	5	4.90	1	100
9. Ability to lead customer behavior change	5	4.60	4	100
10. Ability to use social media	4	4.00	7	90
11. Ability to plan and direct group lessons	4	3.70	9	90
12. Ability to use computer word processing	4	3.80	8	100
13. Health assessment and identification of risk factors	5	4.70	3	100
14. Customer stress assessment and management techniques	4	4.10	6	80
15. Use sports equipment and demonstrate ability	5	4.70	3	90

Table 9

The results of the second Delphi practice expert questionnaire (all levels)

	Importance	
Expertise Indicators	average	rank
Expertise	4.38	3
Professional Attitude	4.76	1
Professional skills	4.51	2

Analysis of the results of the third round of Delphi's questionnaire in the third quarter

The purpose of this section is to explain the third round of the Delphi Technique questionnaire, how to summarize and organize the questionnaires after the questionnaires are collected, collect the opinions of the experts on the professional ability indicators of physical fitness coaches, and understand the consensus process of the expert members on the evaluation indicators. Opinions on the degree and importance level of the expert members, and whether the expert members adjust the importance level opinions of each evaluation target after referring to the distribution percentage of the importance levels of other expert members, and also understand the degree of agreement and importance level of the expert members on the newly added evaluation index items, as the basis for confirming the final questionnaire results.

Table 10

Results of the third Delphi technique expert questionnaire (professional knowledge)

	Importance		**Consistency**	
Expertise Indicators	Median	Average	Rank	Agree rate (%)
1. Career development in the fitness industry	4	4.20	7	80
2. How to conduct personal training sessions based on education	4	4.20	7	90
3. Practicing relationship with clients	5	4.60	4	90
4. Understand the future development direction of personal fitness coaching	4	4.20	7	80
5. Exercise Physiology	5	4.80	2	100
6. Anatomy, Kinesiology and Biomechanics	5	4.80	2	100
7. Learning motor skills	5	4.80	2	100
8. Pedagogy and Client Learning Courses	4	4.30	6	100
9. Sports Psychology, Motivation and Behavior Change	4	4.40	5	100
10. Nutrition	4.5	4.40	5	100
11. Customer initial consultation	5	4.70	3	80
12. Objective goal setting between client and individual fitness coach determination and method	4.5	4.40	5	100
13. Risk Screening and Classification	5	4.70	3	100
14. Customer health and fitness testing	5	4.60	4	100
15. Client exercise course design	5	4.90	1	100
16. resistance training schedule	5	4.80	2	100
17. Cardio training schedule	5	4.80	2	100
18. Design Flexibility Schedule Policy	5	4.70	3	90
19. Sequence of personal training schedules	5	4.70	3	100
20. Business Fundamentals and Planning	4	3.70	11	80
21. Legal Terms and Liability	4	4.20	7	100
22. Sports injury protection and health care	4	4.10	8	100
23. sports medicine	4	3.90	10	90
24. sports coaching	3	3.70	11	80
25. sports training	4	4.00	9	100
26. Sports Program Administration and Management	3	3.40	12	80

Table 11

Results of the third Delphi technique expert questionnaire (professional attitude)

Expertise Indicator	Median	Average	Rank	Consent Rate (%)
1. Continue to absorb and learn sports science information	5	4.80	3	100
2. Respect customer privacy	5	4.90	2	100
3. Set career development goals	5	4.60	5	100
4. Good time management	5	4.90	2	100
5. Maintain a positive and enthusiastic professional attitude	5	5.00	1	100
6. Excellent customer service and attention program	5	4.70	4	100
7. Maintain good communication and listening with customers	5	4.90	2	100
8. High EQ with empathy	5	4.90	2	100
9. Give customers training autonomy	5	4.70	4	100
10. Stay in touch with other health experts	5	4.60	5	100
11. Self-maintaining good posture and lifestyle	4.5	4.50	6	100

Table12

Results of the third Delphi technique expert questionnaire (professional skills)

	Importance		Consistency	
Expertise Indicator	Median	Average	Rank	Consent Rate (%)
1. Physical fitness test execution and demonstration ability	5	4.70	3	100
2. Ability to interpret physical fitness test results	5	4.80	2	100
3. Physical fitness training cycle plan design ability	5	4.90	1	100
4. Physical fitness training exercise demonstration ability	5	4.80	2	100
5. Physical fitness training program record ability	5	4.80	2	100
6. Physical fitness action correction ability	5	4.90	1	100
7. Sports injury assessment and protection ability	4	4.20	5	100
8. Ability to respond to emergencies	5	4.90	1	100
9. Ability to lead customer behavior change	5	4.60	4	100
10.Ability to use social media	4	3.90	6	90
11.Ability to plan and direct group lessons	4	3.70	7	90
12.Ability to use computer word processing	4	3.70	7	100
13.Health assessment and identification of risk factors	5	4.70	3	100
14.Customer stress assessment and management techniques	4	3.90	6	80
15.Use sports equipment and demonstrate ability	5	4.90	1	90

Table 13

Results of the third Delphi technique expert questionnaire (all levels)

	Importance	
Expertise Indicators	Average	Rank
Professional knowledge	4.38	3
Professional Attitude	4.76	1
Professional skills	4.49	2

In the third expert questionnaire on fitness coaches' professional ability indicators, the expert members believed that in the "professional knowledge" level, "customer sports curriculum design" is the most important. In the "professional attitude" level, "maintaining a positive and enthusiastic dedication" is the most important. In the "professional skills" level, "physical fitness training cycle planning and design capabilities", "Physical fitness and movement correction ability", "Emergency response ability", "Sports equipment use and demonstration ability" are the most important. According to the compilation of the third physical fitness coach's professional ability index questionnaire, each level is "professional attitude", "professional skills" and "professional knowledge" in order of importance.

Discussion

After the compilation of the expert questionnaire on the professional ability index of personal fitness coaches, three professional ability levels were found. According to the analysis results of experts' opinions, the order of importance is "professional attitude", "professional skills", and "professional knowledge". According to the opinions of expert members, it is highly important to know the ability index of "Personal Fitness Coach Professional Ability Index", The "Personal Fitness Coach Professional Competency Index" in this study is divided into three levels, a total of 52 evaluation indexes, and the order of importance is "professional attitude ", "professional skills", and "professional knowledge". Professional attitude is regarded as the most important aspect. It can be seen, that the expert members believe that the professional attitude of a personal fitness coach is the highest priority in his professional ability indicators, followed by professional skills, and then professional Knowledge. In the "professional attitude" item, the most important is "maintaining enthusiasm and positive professional attitude". And "professional attitude" has a direct impact on customer satisfaction, and an indirect impact on customer loyalty (Seeman, O'Hara 2006; Mohammed, Bachir, Eddine, Adel 2018; Lalia, Ali, Adel, Asli, Othman 2019; Beboucha, Belkadi, Benchehida, Bengoua 2021) and individual fitness coaches determine the students' intention to participate in sports to a certain extent (Liakopoulou 2011; yassin zenati, belkadi, benbernou 2021). The author also serves as a personal fitness coach and international club leader (Adel et al. 2019), and fully understands the multiple roles of teaching, management and marketing in the highly competitive fitness industry (Viallon, Camy, Collins 2003).

Personal fitness coaches, who have been in contact with the public for a long time every day, can easily lead to a decline in the quality of teaching due to multiple factors, which will

affect the motivation and long-term behaviour changes of the public to participate in fitness sports (Sawka et al. 2007; Mokhtar et al. 2019; Saddek et al. 2020).

"Professional skills" is regarded as the second most important professional ability level among experts and scholars (Belkadi et al. 2015; Belkadi, Benchehida, Benbernou, Sebbane 2019; Mohamed, Mohamed, Mohammed, Mokrani, Belkadi 2019). The four abilities that are valued are: "Physical fitness training cycle plan design ability", "Physical fitness movement correction ability", "Emergency Response Ability", "Sports Equipment Use and Demonstration Ability". These skills are equally important but if not "Physical fitness training cycle plan design ability" cannot connect professional knowledge (Adel, Alia, Mohammed 2020; Benhammou, Mourot, Mokkedes, Bengoua, Belkadi 2021). Without "sports equipment use and demonstration ability" and "physical fitness movement correction ability", it is impossible to correctly demonstrate and correct training movements for customers. In turn, it affects the guidance operation, which is one of the highly demanded abilities of sports instructors (Astin 1984; Epstein, Hundert 2002; Luo et al. 2019; Organization 2019). Personal fitness coaches face all kinds of people in the society (Orfaly et al. 2005), and everyone's physical condition is different. If they do not have the "capacity to respond to emergencies", they will not be able to best deal with special situations when they occur, which may lead to people's rights and interests in life. damage. Although the importance of "professional knowledge" is placed last, its status is still very important, and "customer sports curriculum design" is regarded as the most important indicator (Melton, Katula, Mustian 2008). The foundation of "customer exercise curriculum design" is established after clear understanding of various professional knowledge, through the "physical fitness training cycle planning design ability" to integrate and connect them, Rather than randomly prescribing exercise prescriptions (Van Der Vleuten, 1996). The results of this study present the professional competency framework of personal fitness coaches, which should be of reference value in any organization or team that needs personal fitness coaching (Kranz et al. 2013; Thompson 2015; Malm et al. 2019).

Conclusions

Based on the research results and discussion "Personal Fitness Coach Professional Ability Index" constructed by literature analysis and expert opinions includes three levels and 52 indicators, including: 1. Professional knowledge level 26 One indicator item; 2. Professional attitude 11 three index items; 3. professional skills level 15 an indicator item. According to the importance level, it is divided into "high" importance, "medium-high" degree of importance and

"medium" degree of importance, because the indicators in this research are all above "moderate" degree of importance (inclusive), so there is no index item below "moderate" degree of importance. "Professional attitude" is the professional index ranked No. 1. Among its 11 index items, "maintaining enthusiasm and positive professional attitude" is the most important professional ability identified by the expert panel. "Professional skills" is the second-ranked professional index, and four of the 15 index items are: "Physical Fitness Training Cycle Plan Design Ability", "Physical Fitness Action Correction Ability", "Emergency Response Ability" and "Sports equipment use and demonstration ability" were identified as the most important by the expert group. Among the 26 "professional knowledge" indicators, "customer sports curriculum design" is the most important.

Recommendation

It is hoped that the results summarized in this study can be used as a reference for the future Algerian personal fitness coaching system. A complete system requires qualified certificates to be recruited and qualified. And participate in the development of the personal fitness coach certificate, in order to understand its importance to employers and sports clients, we can create a win-win situation of health promotion, professional division of labour and reasonable profits.

References

1. ABRAHAM, A., D. COLLINS, R. MARTINDALE, 2006. The coaching schematic: Validation through expert coach consensus. *Journal of Sports Sciences*. **24**(06), 549-564.
2. ADE, B., B. ABDELKADER, C. ALIA, B. OTHMAN, S. MOHAMED, A. HOUCIN, 2019 The Effect of High-Intensity Exercise on Changes of Blood Concentration Components in Algerian National Judo Athletes. *Acta Facultatis Educationis Physicae Universitatis Comenianae*. **59**(2), 148–160. https://doi.org/10.2478/afepuc-2019-0013.
3. ADEL, B., C. ALIA, Z. MOHAMMED, 2020. Algerian Judo Competition Modality and its Impacts on Upper and Lower Limbs Strength Perseverance and Limitations. *Orthopedics and Sports Medicine: Open Access Journal*. **3**(4), 293-299. ohttps://doi.org/10.32474/OSMOAJ.2020.03.000168.
4. ADEL, B., S. MOHAMMED, 2017. Study of perception of professional competences in teachers in relation to the requirements of the profession of teaching physical education. *European Journal of Education Studies*. **0**(0). Retrieved from http://oapub.org/edu/index.php/ejes/article/view/918.

5. ASTIN, A. W., 1984. Student involvement: A developmental theory for higher education. *Journal of College Student Personnel*. **25**(4), 297-308.
6. AVELLA, J. R., 2016. Delphi panels: Research design, procedures, advantages, and challenges. *International Journal of Doctoral Studies*. **11**, 305.
7. BEBOUCHA, W., A. BELKADI, A. BENCHEHIDA, A. BENGOUA, 2021. The anthropometric and physiological characteristics of young algerian soccer players. *Acta Facultatis Educationis Physicae Universitatis Comenianae*. **61**(1).
8. BELKADI, A., A. BENCHEHIDA, O. BENBERNOU, M. SEBBANE, 2019. Competencies and training needs and its impact on determining the professional skills of Algerian elite coaches. *International Journal of Physical Education, Fitness and Sports*. **8**(3), 51-61. https://doi.org/10.26524/ijpefs1936.
9. BELKADI, A., B. OTHMAN, S. MOHAMED, J. GLEYSE, B. ADEL, B. OTHMAN, S. MOHAMED, L. M B. H. ABDELHAFID, J. GLEYSE, 2015. Contribution to the Identification of the Professional Skills Profile of Coaches in the Algerian Sport Judo System. *International Journal of Sports Science*. **5**(4), 145-150.
10. BENHAMMOU, S., L. MOUROT, M. I. MOKKEDES, A. BENGOUA, A. BELKADI, 2021. Assessment of maximal aerobic speed in runners with different performance levels: Interest of a new intermittent running test. *Science & Sports*. https://doi.org/10.1016/j.scispo.2020.10.002.
11. BLOOM, G. 1997. *Characteristics, knowledge, and strategies of expert team sport coaches.* (Thesis). University of Ottawa (Canada),. Retrieved from http://ruor.uottawa.ca/handle/10393/9903.
12. CUSHION, C. J., K. M. ARMOUR, R. L. JONES, 2003. Coach Education and Continuing Professional Development: Experience and Learning to Coach. *Quest*. **55**(3), 215-230. https://doi.org/10.1080/00336297.2003.10491800.
13. DOĞAN, C., 2015. Training at the Gym, Training for Life: Creating Better Versions of the Self Through Exercise. *Europe's Journal of Psychology*. **11**(3), 442-458. https://doi.org/10.5964/ejop.v11i3.951.
14. EPSTEIN, R. M., E. M. HUNDERT, 2002. Defining and assessing professional competence. *Jama.* **287**(2), 226-235.
15. GNATZY, T., J. WARTH, H. VON DER GRACHT, I. L. DARKOW, 2011. Validating an innovative real-time Delphi approach-A methodological comparison between real-time and conventional Delphi studies. *Technological Forecasting and Social Change*. **78**(9), 1681-1694.
16. HASSON, F., S. KEENEY, H. MCKENNA, 2000. Research guidelines for the Delphi survey technique. *Journal of Advanced Nursing*. **32**(4), 1008-1015.
17. HUGHES, M. D., R. M. BARTLETT, 2002. The use of performance indicators in performance analysis. *Journal of Sports Sciences*. **20**(10), 739-754.

18. HUMS, M. A., C. A. BAR, L. GULLION, 1999. The ethical issues confronting managers in the sport industry. *Journal of Business Ethics.* **20**(1), 51-66.
19. KIRSCHNER, P., P. VAN VILSTEREN, H. HUMMEL, M. WIGMAN, 1997. The Design of a Study Environment for Acquiring Academic and Professional Competence. *Studies in Higher Education.* **22**. https://doi.org/10.1080/03075079712331381014.
20. KRANZ, M., A. MÖLLER, N. HAMMERLA, S. DIEWALD, T. PLÖTZ, P. OLIVIER, L. ROALTER, 2013. The mobile fitness coach: Towards individualized skill assessment using personalized mobile devices. *Pervasive and Mobile Computing.* **9**(2), 203-215.
21. KUNTER, M., U. KLUSMANN, J. BAUMERT, D. RICHTER, T. VOSS, A. HACHFELD, 2013. Professional competence of teachers: effects on instructional quality and student development. *Journal of Educational Psychology.* **105**(3), 805.
22. LADYSHEWSKY, R. K., 2010. Building competency in the novice allied health professional through peer coaching. *Journal of Allied Health.* **39**(2), 77E-82E.
23. LALIA, C., A. R. ALI, B. ADEL, H. ASLI, B. OTHMAN, 2019. Effects of caloric restriction on anthropometrical and specific performance in highly-trained university judo athletes. *Physical Education of Students.* **23**(1), 30-36.
24. LIAKOPOULOU, M., 2011. The Professional Competence of Teachers: Which qualities, attitudes, skills and knowledge contribute to a teacher's effectiveness. *International Journal of Humanities and Social Science.* **1**(21), 66-78.
25. LILLY, M. S., 1979. Competency-based training. *Teacher Education and Special Education.* **2**(3), 20-25.
26. LUO C.-C., Y. -C. WANG, Y. -F., 2019. Effective training methods for fostering exceptional service employees. *Journal of Hospitality and Tourism Insights*.
27. LYLE, J., 2002. *Sports Coaching Concepts: A Framework for Coaches' Behaviour*. Routledge, London, p. https://doi.org/10.4324/9780203994986.
28. MALM C., J. JAKOBSSON, A. ISAKSSON, 2019. Physical activity and sports—real health benefits: a review with insight into the PUBLIC HEALTH OF SWEDEN. *SPORTS.* **7**(5), 127.
29. MELTON, D. I., J. A. Katula, K. M. Mustian, 2008. The current state of personal training: An industry perspective of personal trainers in a small southeast community. *Journal of Strength and Conditioning Research/National Strength & Conditioning Associatio.* **22**(3), 883.
30. MOHAMED K. S., K. MOHAMED, S. MOHAMMED, D. MOKRANI, A. BELKADI, 2019. The Effect of Heavy Weight Training on Physiological Abilities of Soccer Players Under the Age 21 Years Old. *Acta Facultatis Educationis Physicae Universitatis Comenianae*. **59**(1), 33-43. https://doi.org/10.2478/afepuc-2019-0004.
31. MOHAMMED, B., K. BACHIR, S. N. EDDINE, B. ADEL, 2018. Study of LDH adaptations associated with the development of Speed endurance in basketball players U19. *International Journal of Applied Exercise Physiology.* **7**(3), 35-43.

32. MOKHTAR, M., B. ADEL, B. WAHIB, A. HOCINE, B. OTHMAN, S. MOHAMED, 2019. The effects of tow protocol cold water immersion on the post match recovery and physical performance in well-trained handball players. *Pedagogics, Psychology, Medical-Biological Problems of Physical Training and Sports.* **23**(6), 288-295.
33. ORFALY, R. A., J. C. FRANCES, P. CAMPBELL, B. WHITTEMORE, B. JOLY, H. KOH, 2005. Train-the-trainer as an educational model in public health preparedness. *Journal of Public Health Management and Practice*. **11**(6), S123-S127.
34. ORGANIZATION, W. H., 2019. *Global action plan on physical activity 2018-2030: more active people for a healthier world*. World Health Organization.
35. ORGANIZATION, W. H., Ageing W. H. O., Unit L. C. 2008 *WHO global report on falls prevention in older age*. World Health Organization.
36. PARLE, M., P. MAGUIRE, C. HEAVEN, 1997. The development of a training model to improve health professionals' skills, self-efficacy and outcome expectancies when communicating with cancer patients. *Social Science & Medicine.* **44**(2), 231-240.
37. PIERCY K. L., R. P. TROIANO, R. M. BALLARD, S. A. CARLSON, J. E. FULTON, D. A. GALUSKA, S. M. GEORGE, R. D. OLSON, 2018. The physical activity guidelines for Americans. *Jama.* **320**(19), 2020-2028.
38. PRATT, M., L. G, PEREZ, S. GOENKA, R. C. BROWNSON, A. BAUMAN, O. L. SARMIENTO, P. C. HALLAL, 2015. Can population levels of physical activity be increased? Global evidence and experience. *Progress in Cardiovascular Diseases*. **57**(4), 356-367.
39. RAFOSS, K., J. TROELSEN, 2010. Sports facilities for all? The financing, distribution and use of sports facilities in Scandinavian countries. *Sport in Society.* **13**(4), 643-656.
40. SADDEK, B., J. B. J. COQUART, L. MOUROT, B. ADEL, M. M. IDRISS, B. ALI, M. DJAMEL, 2020. Comparison of Two Tests to Determine the Maximal Aerobic Speed. *Acta Facultatis Educationis Physicae Universitatis Comenianae*. **60**(2), 241-251. https://doi.org/10.2478/afepuc-2020-0020.
41. SANTOS, S., I. MESQUITA, A. GRAÇA, A. ROSADO, 2010. Coaches' Perceptions of Competence and Acknowledgement of Training Needs Related to Professional Competences. *Journal of Sports Science & Medicine*. **9**(1), 62-70.
42. SAWKA, M. N., L. M. BURKE, E. R. EICHNER, R. J. MAUGHAN, S. J.,MONTAIN, N. S. STACHENFELD, 2007. American College of Sports Medicine position stand. Exercise and fluid replacement. *Medicine and Science in Sports and Exercise.* **39**(2), 377-390.
43. SEEMAN, E. D., M. O'HARA, 2006. Customer relationship management in higher education: using information systems to improve the student-school relationship. *Campus-Wide Information Systems*.

44. SMITH MAGUIRE, J., 2008. The personal is professional: Personal trainers as a case study of cultural intermediaries. *International Journal of Cultural Studies*. **11**(2), 211-229. https://doi.org/10.1177/1367877908089265.
45. THOMPSON, W. R., 2015. Worldwide survey of fitness trends for 2016. *ACSM's Health & Fitness Journal*. **19**(6), 9-18.
46. VAN DER VLEUTEN, C. P., 1996. The assessment of professional competence: developments, research and practical implications. *Advances in Health Sciences Education*. **1**(1), 41-67.
47. VIALLON, R., J. CAMY, M. F. COLLINS, 2003. The European integration of a new occupation, the training and education strategies of national professional organizations: the case of the fitness sector in France and the United Kingdom. *Managing Leisure*. **8**(2), 85-96.
48. YANG, J., M. CHEN, 2022. Construction of Sports and Health Data Resources and Transformation of Teachers' Orientation Based on Web Database. *Journal of Healthcare Engineering*.
49. YASSIN, Z., A. BELKADI, O. BENBERNOU, 2021. Functional Movement Screening as a Predictor of Injury in Highly Trained Female's Martial Arts Athletes. *Polish Hyperbaric Research.* **71**(2), 67-74. https://doi.org/10.2478/phr-2020-0012.

DOI 10.2478/afepuc-2022-0007
© Acta Facultatis Educationis Physicae Universitatis Comenianae 2022, 62(1): 72-82

INTRAINDIVIDUAL EVALUATION OF REACTION TIME AT THE MEN'S WORLD ATHLETICS CHAMPIONSHIPS 1999 - 2019

Peter Mitašík, Ladislava Doležajová, Anton Lednický

Comenius University Bratislava, Faculty of Physical Education and Sport, Slovakia

Summary: The aim of the article was the intraindividual evaluation of reaction time at the Men's World Athletics Championships from 1999 to 2019. We generated the rating of sprinters from the age point of view with comparison of two periods with different false start rules. In the result section, we analysed the sprinters that took part at WCH at least 3 times and appeared in the final. We assessed the reaction speed from the aging point of view, or more different false start judging conditions. The results shows that the stricter start judging rules in sprint disciplines did not have a significant influence on the reaction time. We also confirmed a research that the sprinters over 30 years old sprinters can achieve very low reaction time at the start. Reaction abilities can be improved by regular and systematic training, so it is necessary to pay attention to them in the training process and focus on their monitoring and subsequent improvement.

Key words: athletics, reaction time, world championship, sprinters

Introduction

By many experts the athletics is by considered as a queen of all sports. It has been very popular, not only between professional athletes but also among the general public. We focused in the article on the most popular athletic disciplines, the short distance sprints. The matter is an analysis of reaction times, which is a significant part of it (Mitašík & al. 2020/a, Mitašík & al. 2020/b,). There is a simple reaction to an acoustic stimulus when speaking about short distance sprint start. In these modern ages performance top level sprinters are differentiated only by hundredths of seconds and often are decisive of winners. Reaction speed is measurable by technical equipment into number, which is known as reaction time. Gunfire is the starting stimulus in athletics which means the sprinters react to an acoustic stimulus. Every competitor

that commits a false start (besides combined disciplines), will be disqualified, under the authority of the rule since 1. January 2010. Before year 2010 (SAZ 2010).

The level of reaction time is influenced by number of factors, e.g. age (Fozard et al. 1994), gender (Jain, Bansal, Kumar and Singh 2015), warm-up (Magner et al. 2012), fatigue Brisswalter, Arcelin, Audiffren and Deligniéres (1997), training level (Jawoski, Lech, Ambrozy and Zak 2020), power of the start impulse (Germain, Smith, Maslovat and Carlsen 2020), running distance (Glesk 1986), psychological preparation (Kampmiller and Vanderka 2012), sprinters character (sport.cz).

Reaction time is shorter until 20th year of life, then gradually in slow pace prolongs to the 60 year of life. People over the age of 70 have the the longest reaction time, Jevas and Yan (2001) Luchies et al. (2002) Rose et al. (2002) Der and Deary (2006). The reaction time is influenced by psychological phenomenon as well, whereas older people tend to be more careful and think more (Botwinic 1966). MacDonald at al. (2002) observed adults and seniors, finding out that the variety of reaction time is possible to connect with generally slower reaction times to a specific stimulus.

Because human body is not able to keep a constant level of performance throughout the day, this fact influences reaction time too. Štulrajter et al. (1989) focused their research on oscillation of reaction time during the day in accordance with biorhythm of the human body. The reaction time values measured over 24 hours proved to be significantly oscillating. It shows that the shortest reaction time is in the morning before nine o'clock and in the evening after 18 o'clock.

In their research, Tønnessen and Haugen (2013) analyzed the reaction time of elite sprinters (n = 1319) who took part in the World Championships during years 2003-2009 showed that women over 30 years of age achieved the fastest reaction time compared to women under 30 years (0.153 ± 0.020s).

Methods

We carried out the research on a group of selected elite sprinters in the 100 m run, which took part in several finals at the World Championships in Athletics in the years 1999 – 2019. In the first period (1999 – 2009) we watched the runners in the heats, the quarterfinals, the semifinals and in the final runs. In the second period (2011 – 2019) quarter-final runs were excluded from the program. We obtained the figures of the starting time of sprinters from the mentioned periods from the official website of the IAAF (WA). We presented the results of

selected athletes in figure and tables. In the final part, we analyzed the competitors who participated in the World Championships at least three times and reached the finals. We assessed their reaction rate in terms of increasing age, respectively, different conditions of assesing a false start. We evaluated the reaction speed according to Gaval' (2002), who set aside five levels: excellent (100 – 130 ms), very good (131 – 160 ms), average (161 – 185 ms), below average (186 – 210 ms) and unsatisfactory (211 and more ms).

Results

Selected competitors reached a reaction speed at an excellent, regardless of their age, respectively, the period in which they ran in the finals (Table 1). In some cases (Justina Gatlin, Tyson Gay) they had the fastest reaction at their older age. This finding is confirmed by Tønnessen and Haugen (2013) that the reaction speed can be maintained and developed at an older age. In the table 1 below we see large intra-individual rates of reaction times of monitored sprinters not only in individual monitored years, but also in their entire compared period. Importantly the very low reaction times in the finals gave advantage to the athletes and higher possibility to win the medals (Justin Gatlin 0.138 and 1st place; Tyson Gay 0.143 and 1st place; Justin Gatlin 0.138 and 1st place).

Table 1

Reaction speed of selected athletes, multiple finalists in the 100 m run at the World Athletics Championships

Year	Name	Reaction time				Time in final [s]	Placenent (finals)	Age (years)
		Heats [s]	Quaterfinals [s]	Semifinals [s]	Finals [s]			
2001	**Kim COLLINS**	**0.162**	**0.174**	**0.141**	**0.162**	**10.07**	**5.**	**25**
2003	**Kim COLLINS**	**0.167**	**0.160**	**0.227**	**0.148**	**10.07**	**1.**	**27**
2005	**Kim COLLINS**	**0.148**	**0.142**	**0.146**	**0.146**	**10.05**	**3.**	**29**
2011	**Kim COLLINS**	**0.158**		**0.161**	**0.155**	**10.09**	**3.**	**35**
2005	Justin GATLIN	0.140	0.164	0.141	0.157	9.88	1.	23
2013	Justin GATLIN	0.168		0.157	0.163	9.85	2.	31
2015	Justin GATLIN	0.149		0.153	0.165	9.80	2.	33
2017	Justin GATLIN	0.149		0.152	0.138	9.92	1.	35
2019	Justin GATLIN	0.176		0.198	0.148	9.89	2.	37
2007	**Tyson GAY**	**0.172**	**0.203**	**0.170**	**0.143**	**9.85**	**1.**	**25**
2009	**Tyson GAY**	**0.194**	**0.155**	**0.143**	**0.144**	**9.71**	**1.**	**27**
2015	**Tyson GAY**	**0.137**		**0.117**	**0.128**	**10.00**	**6.**	**33**
2009	**Usain BOLT**	0.144	0.155	0.135	0.146	9.58	1.	23
2011	**Usain BOLT**	0.153		0.164	0.000	0.000	8.	25
2013	**Usain BOLT**	0.155		0.173	0.163	9.77	1.	27
2015	**Usain BOLT**	0.152		0.148	0.159	9.79	1.	29
2017	**Usain BOLT**	0.166		0.166	0.183	9.95	3.	31

The reaction speed of selected finalists compared to the average rates of all finalists (Table 2) was often better. E.g. in 2011, Collins had a reaction rate of 0.155 s, the average time of the finalists was 0.166 s; in 2017 Gatlin had a reaction speed of 0.138 s, the average time of the finalists was 0.155 s.

The reaction speed of selected finalists was also often comparable to the average rates (in 2013 Gatlin reached 0.163 s, the average of the finalists was the same; in 2009 Gay and Bolt had a reaction speed of 0.144/0,146 s, the average time was 0.139 s; in 2003 Collins had a speed reaction 0.148 s, the average was 0.141 s, or worse (in 2001 Collins had a reaction rate of 0.162, the average of the finalists was at the level of 0.149 s; in 2015, Gatlin reacted at a speed of 0.165 s, but the average was 0.147 s).

Table 2

Average age and reaction speed of finalists in100 m sprint in 1st and 2nd observed period

Period	WCH	Average age (years)	Average reaction time (final) [s]
1.	1999	25.00	0.141
	2001	24.88	0.149
	2003	26.13	0.141
	2005	25.38	0.142
	2007	25.13	0.153
	2009	26.63	0.139
Average		25.53	0.144
Max.		26.63	0.153
Min.		24.88	0.139
Vr		1.75	0.014
2.	2011	24.75	0.166
	2013	25.88	0.163
	2015	27.75	0.147
	2017	26.63	0.155
	2019	26.63	0.138
Average		26.33	0.154
Max.		27.75	0.166
Min.		24.75	0.138
Vr		3	0.028

The results confirm (Table 2) that the stricter assessment of starts in sprint disciplines did not have effect on the reaction speed. In the second period, the runners had almost the same average reaction time (+0.012 s) and big difference were also in the slowest (+0,013 s) and small difference in the fastest reaction (-0.001 s).

However, the mentioned differences in the balance of the top sprinters often mean the difference of one, resp. two places in the overall standings. E.g. MS 2001: 3. Boldon 9.98 s (reaction rate 0.148), 4. Chambers 9.99 s (0.160); MS 2003: 2. Brown 10.08 s (0.152), 3. Campbell 10.08 s (0.112); MS 2005: 2. Frater 10.05 s (0.141), 3. Collins 10.05 s (0.146); MS 2011: 2. Dix 10.08 s (0.175), 3. Collins 10.09 s (0.155).

In the individual assessment of changes in reaction time, we analyzed the competitors who participated in the World Championships three or more times, always participating to the finals.

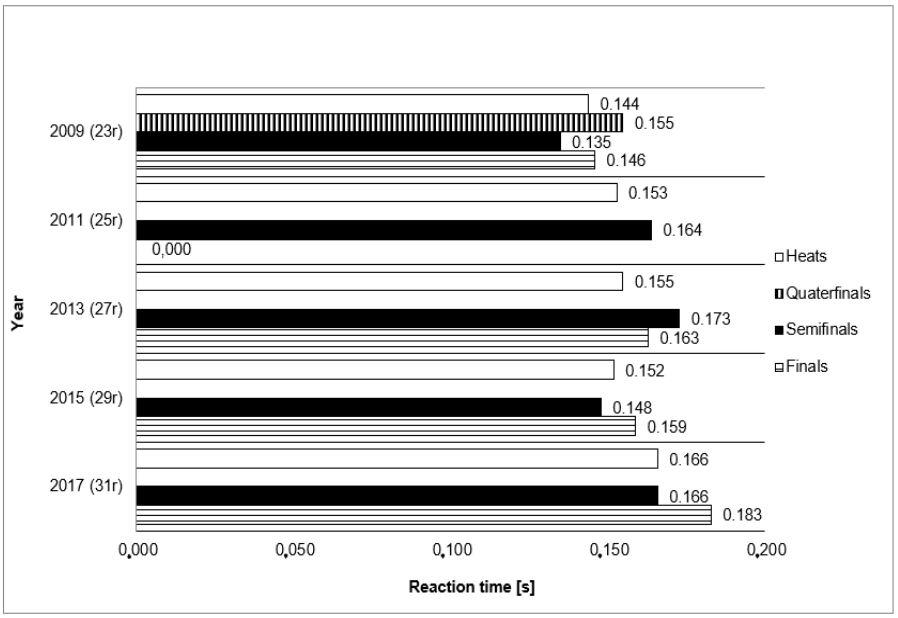


Figure 1

Intra-individual evaluation of the Usain Bolt reaction time at the World Championships in the 100 m run

The competitor achieved a reaction time of less than 0.2 s on all MS. His reactions ranged mostly from average to below average (according to Gaval 2002). After changing the rule, the runner reached the same reaction speed.

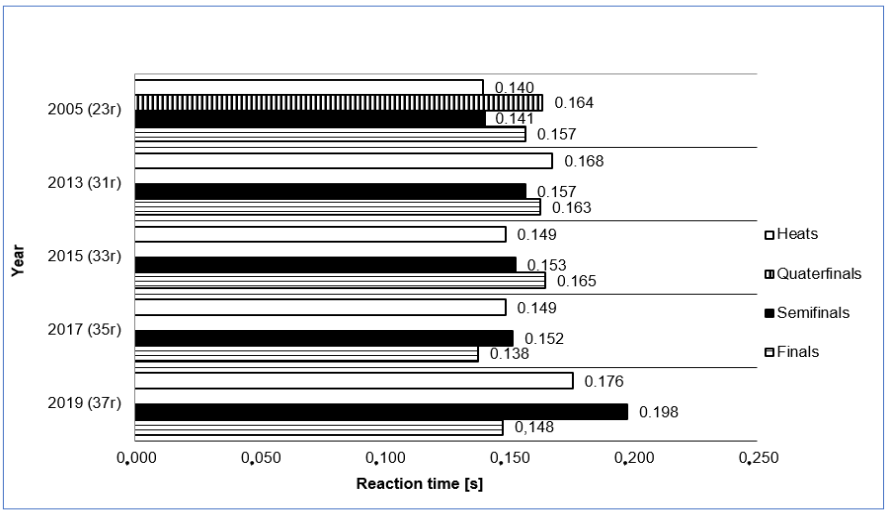


Figure 2

Intra-individual evaluation of the reaction time Justin Gatlin at the World Championships in the 100 m run

The reaction times of the competitors were stable at good level throughout the 12-year period. It approached very good level of reaction speed. Most of the times were very good and only two times were in the average category. The athlete competed in both periods. There is practically no difference in the speed of the reaction between the first and the second period.

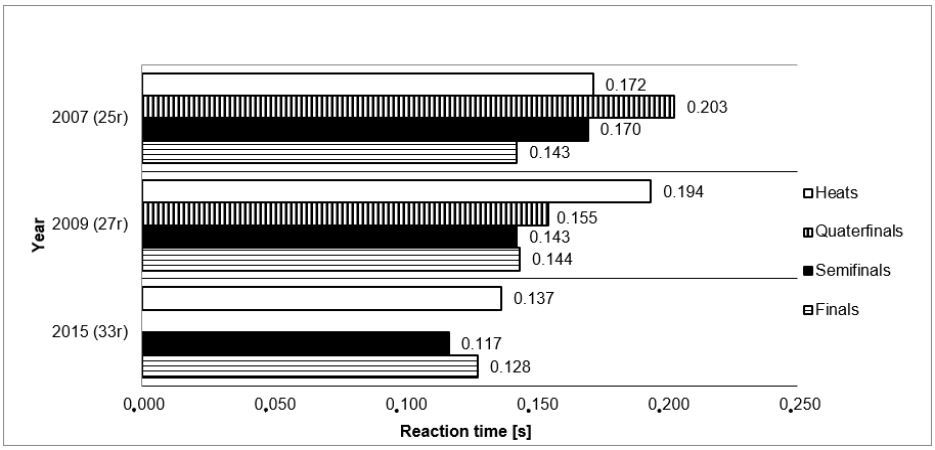


Figure 3

Intra-individual evaluation of the reaction time of Tyson Gay at the World Championships in the 100 m run

When analyzing the reaction time of this competitor, you can see the instability of the speed on the first two MS in first period, on which the reaction speed was close to excellent, resp. below average level. There is difference in the speed of the reaction between the first and the second period. His speed of reaction time in second period was excellent. In semifinal run (0.117 s) and in final run (0,128 s).

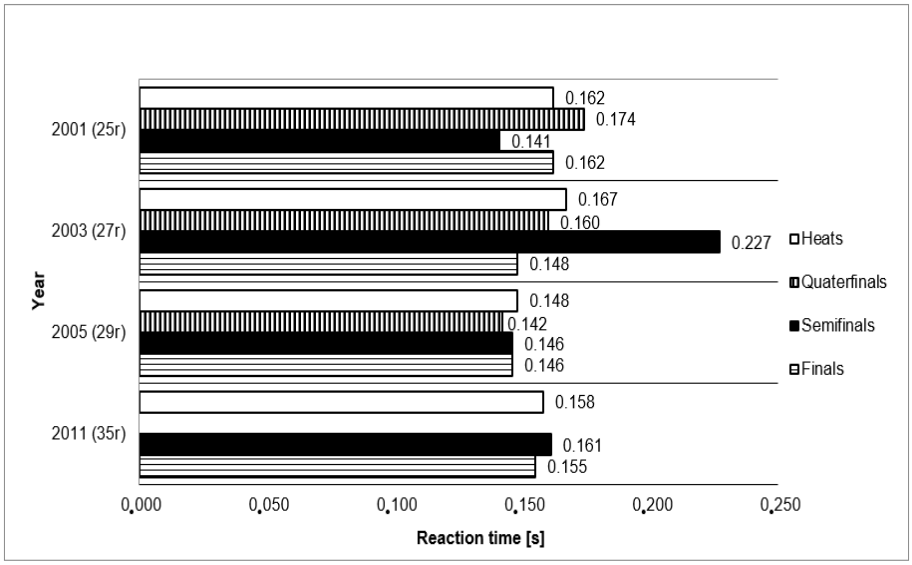


Figure 4

Intra-individual evaluation of the reaction time of Kim Collins at the World Championships in the 100 m run

The competitor achieved a reaction rate of less than 0.2 s on all MS, except for the semifinal in 2003. His reaction times ranged mostly from very good to average (according to Gaval 2002). After tightening the rule, the runner reached the same reaction time.

Table 3

The average age and reaction time of sprinters at the World Championships in the final of the 100 m run in individual years

	1999	2001	2003	2005	2007	2009	2011	2013	2015	2017	2019
Average age (years)	25.00	24.88	26.13	25.38	25.13	26.63	24.75	25.88	27.75	26.63	26.63
Average reaction time [s]	0.141	0.149	0.141	0.142	0.153	0.139	0.166	0.163	0.147	0.155	0.138

Table 3 shows the age of the competitors did not affect the reaction speed in the final runs. At an average age of about 25 years, we recorded an average reaction time of 0.141and 0.153 s, respectively, at about 27 years of age 0.147 and 0.138 s. The speed of the reaction, as we mentioned, is influenced by many factors, and even in older age it is possible to achieve an excellent level of reaction speed. The correlation between these two parameters is shown in Figure 7.

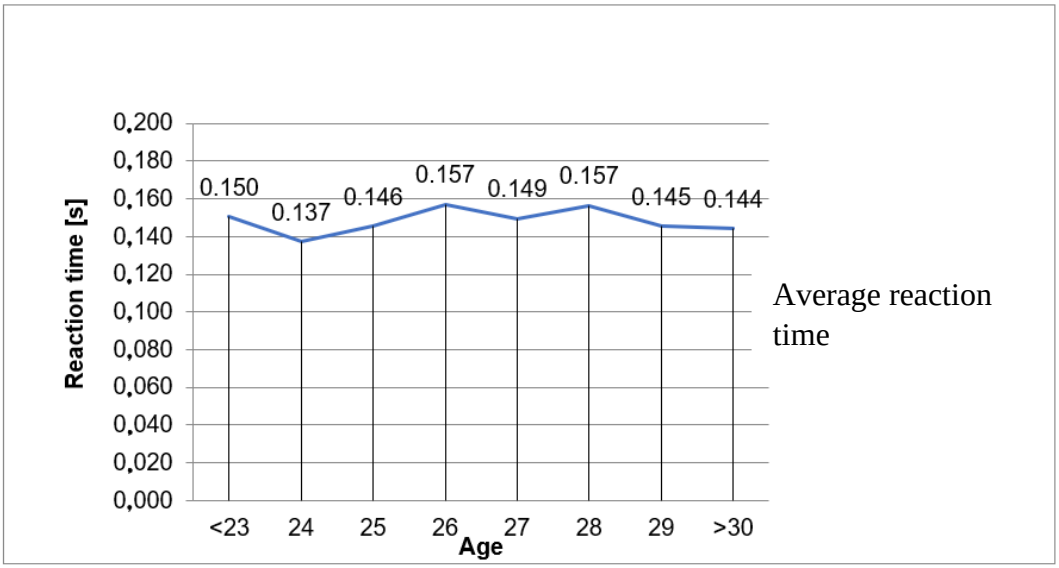


Figure 5

Development of the average reaction time of men´s in the 100 m run at the World Championships in the final runs in correlation with age

Conclusion

1. By analyzing the starting reaction time of the top runners at 100 m at the World Championships in Athletics, we found that two different rules for judging a failed start did not have a good effect on prolonging the reaction speed even after tightening the rule.
2. Despite the conclusions of some authors about the slowing down of the reaction rate with increasing age, some competitors refuted them and achieved the best reaction times over the age of 30. They confirmed that training can not only maintain but also improve this indicator.
3. Although we analyzed the top competitors, only a few of them achieved an excellent level of reaction speed (100 – 130 ms) according to the Gavaľa scale (2002).
4. In addition to the above, the reaction speed is influenced by other important factors - the time zone in which the competitor moved to the race; the weather; quality of opponents.

In study Pavlovic (2021) based on the obtained results, a positive but low correlation was recorded between the mean values of the 100 m sprint results and the reaction time in men ($r = 0.230$ $p < 0.044$), which was also confirmed by regression analysis. In other correlations and values of regression coefficients, no significant numerical values of the influence of reaction time on the result success were recorded in both categories of finalists.

Study of Brosnan et al. (2016) analysed all available World and European Championship reaction time data from 1999 to 2014 to examine effects of rule changes on

competition reaction time at major championships. The exponentially modified Gaussian distribution was used to model reaction time and make comparisons relative to athletes' sex, ruling periods and competition rounds. Revised reaction time thresholds of 115 ms and 119 ms were identified for men and women, respectively, indicating that the current 100 ms rule could result in some false starts not being detected in competitive athletics. The study proposes that when using existing International Association of Athletics Federations approved systems, the false start detection threshold should be increased and that men and women athletes should have different thresholds because of substantial evidence of a sex-based difference in RT in elite-standard athletes.

The results of Ntolaptsis (2021) showed that reaction time was significantly different ($p < 05$) before and after the change of the rules at 2009. A weak, but significant, positive correlation ($r = .228$, $p = .016$) between reaction time and time of 60 m hurdles was observed. Results revealed that reaction time is a factor that affects time of 60 m hurdles. In conclusion, the essential focus on the reaction time at the starting blocks must be given during the training process.

References

1. BOTWINICK, J., & L. W. THOMPSON, 1966. Components of reaction time in relation to age and sex. *The Journal of Genetic Psychology: Research and Theory on Human Development.* ***108***(2), 175-183. https://doi.org/10.1080/00221325.1966.10532776.
2. BRISSWALTER, J., R. ARCELIN, M. AUDIFFREN & D. DELIGNIERES,1997. Influence of Physical Exercise on Simple Reaction Time: Effect of Physical Fitness. *Perceptual and Motor Skills.* ***85***(3), 1019–1027. https://doi.org/10.2466/pms.1997.85.3.1019.
3. BROSNAN, K., K. HAYES, A. HARRISON, 2016. Effects of false-start disqualification rules on response-times of elite-standard sprinters. *Journal of Sports Sciences.* 35. http://dx.doi.org/10.1080/02640414.2016.1201213.
4. DER, G., & I. J. DEARY, 2006. Age and sex differences in reaction time in adulthood: Results from the United Kingdom Health and Lifestyle Survey. *Psychology and Aging.* ***21***(1), 62–73. https://doi.org/10.1037/0882-7974.21.1.62.
5. FOZARD, J. L., M. VERCRYSSEN, S. L. REYNOLDS, P. A. HANCOCK & R. E. QUILTER, 1994. Age differences and changes in reaction time: the Baltimore Longitudinal Study of Aging. *Journal of gerontology.* ***49***(4), P179–P189.

https://doi.org/10.1093/geronj/49.4.p179.

6. GLESK, P., 1986. Behy na krátke vzdialenosti. In *Atletika behy.* Bratislava, 15-39. ISBN: 77-028-8611-4.
7. HULTSCH, D. F., S. W. MACDONALD & R. A DIXON, 2002. Variability in reaction time performance of younger and older adults. *The journals of gerontology. Series B, Psychological sciences and social sciences. **57***(2), P101–P115. https://doi.org/10.1093/geronb/57.2.p101.
8. JAIN, A., R. BANSAL, A. KUMAR & K. D SINGH, 2015. A comparative study of visual and auditory reaction times on the basis of gender and physical activity levels of medical first year students. *International journal of applied & basic medical research*. ***5***(2), 124-127. https://doi.org/10.4103/2229-516X.157168.
9. JAWOSKI, J., T. G.LECH, M. AMBROZY ZAK, 2020. Profile of coordination motor abilities in elite judokas and badminton players compared to non-athletes. *Biomedical human kinetics*. **12**, 17-24. http://apps.webofknowledge.com/full_record.do?product=WOS& search_mode=GeneralSearch&qid=1&SID=F5vn6HSLeXqB6j8USYQ&page=1&doc=1.
10. KAMPMILLER, T. a M. VANDERKA, 2012. Rýchlostné schopnosti a ich rozvoj. In T. KAMPMILLER, M. VANDERKA, E. LACZO & P. PERÁČEK (Eds.). *Teória športu a didaktika športového tréningu* (s. 157-177). ICM Agency. ISBN: 978-80-89257-48-5.
11. LUCHIES, C. W., J. SCHIFFMAN, L. G. RICHARDS, M. R. THOMPSON, D. BAZUIN, & A. J. DEYOUNG, 2002. Effects of age, step direction, and reaction condition on the ability to step quickly. *The journals of gerontology. Series A, Biological sciences and medical sciences. **57***(4), M246–M249. https://doi.org/10.1093/gerona/57.4.m246.
12. MAGNER, A., K. CHATHAM, B. SPRADLEY, S. WIRIYAPINT, W. PRICE & T. AKINS, 2012. Static stretching versus dynamic warm-up: The effect on choice reaction time as measured by the Makoto arena 2. *The sport jurnal.* https://thesportjournal.org/article/2012/.
13. MITASIK, P., L. DOLEZAJOVA, A. LEDNICKY & D. VEGH, 2020. Changes in the Start Reaction Times in the 200 m Run at the World Championships After the Tightening of False Start Rule, *Acta Facultatis Educationis Physicae Universitatis Comenianae*. ***60***(2), 207-216. doi: https://doi.org/10.2478/afepuc-2020-0017.
14. MITASIK, P., M. VAVAK, L. DOLEZAJOVA & A. LEDNICKY, 2020. Changes in the start reaction times of male and female sprinters in world athletic championships. *Acta Facultatis. Educationis Physicae Universitatis Comenianae*. ***60***(2)

https:// doi:10.7752/jpes.2020. s. 71.

15. ONLINE MAGAZÍN DENÍKU PRÁVO & Seznam.cz. (n.d.). https://www.sport.cz/.
16. PAVLOVIĆ, R., 2021. The importance of Reaction Time in Athletics: Influence on the Results of Sprint Runs of World Championships Finalists. *Central European Journal of Sport Sciences and Medicine*. http://dx.doi.org/10.18276/cej.2021.2-05.
17. ROSE, S. A., J. F. FELDMAN, J. J. JANKOWSKI & D. M. CARO, 2002. A longitudinal study of visual expectation and reaction time in the first year of life. *Child development.* ***73***(1), 47–61. https://doi.org/10.1111/1467-8624.00391.
18. SLOVENSKÝ ATLETICKÝ ZVÄZ, 2017. *Pravidlá atletických súťaží IAAF* 2018-2019 (pravidlo129,s.14).Bratislava.https://www.atletika.sk/wpcontent/uploads/2018/03/pravidla_atletickych_sutazi_2018-19.pdf.
19. St. GEMAIN, L., V. SMITH, D. MASLOVAT & A. CARLSEN, 2020. Increased auditory stimulus intensity results in an earlier and faster rise in corticospinal excitability. *Brain Research.* **1727**, Article 146559. https://doi.org/10.1016/j.brainres.2019.146559.
20. TONNENSEN, E., T. HAUGEN & S. A. SHALFAWI, 2013. Reaction time aspects of elite sprinters in athletic world championships. *Journal of strength and conditioning research*. **27**(4), 885-892. https://doi.org/10.1519/JSC.0b013e31826520c3.

DOI 10.2478/afepuc-2022-0008
© Acta Facultatis Educationis Physicae Universitatis Comenianae 2022, 62(1): 83-95

POST-PANDEMIC POLICY PRIORITIES FOR FINANCING SPORT AND PHYSICAL ACTIVITY IN THE EU

Jacob Kornbeck

European Commission, Brussels, Belgium and German Sport University, Cologne, Germany

Summary: The most sport-relevant points in a resolution adopted by the European Parliament with regard to the use of post-Covid-19 relief funds from the general budget of the European Union (EU) are highlighted. Members of Parliament (MEPs) have indicated unambiguous preferences for part of the EU funding to be directed towards the need of youth and sport, the latter in particular at grassroots level, and the resolution represents a piece of soft law which should be drawn upon to interpret relevant legal acts such as the relevant financial instrument(s). The article goes on to discuss the implications in relation to traditional sport policies, as opposed to more participation-driven policies following the health-enhancing physical activity (HEPA) paradigm.

Introduction

On 10 February 2021, the European Parliament passed a resolution calling upon Member States to ensure that part of the Covid-19 post-pandemic will be spent on activities related to youth and sport (European Parliament, 2021). MEPs in particular called for spending to be directed towards amateur, community and recreational sport as opposed to high-level, professional, commercialised sports. In practice, this means that Member States must ensure that their national action plans for spending money from EU financial instruments are in line with the expectations of the EP. The article will discuss what this means in terms of privileging either traditional sports policies, favouring specific legal entities, as opposed to participation-driven policies, where public money follows activities and contents (Kornbeck 2019). How does this compare with the previous sport policy record of the EP (Mittag & Naul 2021), of the Council n relation to health-enhancing physical activity (HEPA) (Council of the EU, 2013; Kornbeck,

2021) and, finally, the application of EU law to various sub-sectors of the sport sector (García, Vermeersch & Weatherill 2017)?

The pandemic is taking its toll on people living in the EU, as it is in other parts of the world as well. While measures taking to stem the spread of the virus may be justified from a strictly epidemiological point of view, they lead to novel and sometimes serious problems both at the level of motoric developments, psycho-social as well as mental health and well-being. The trends are unmistakable across a wide range of empirical studies regarding young people, conducted in 2020-21, (for a review, see Naul, Kornbeck & Petkovic 2021) and have been acknowledged in many institutional publications (*ibid.*). But which are the implications for EU relief funds, and have they been acknowledged by the EU Institutions?

Acknowledged policy needs

On 10 February 2021, Parliament voted its 'resolution on the impact of COVID-19 on youth and on sport' (European Parliament 2021), stressing that 'the pandemic is having devastating consequences on the entire sports sector at all levels, especially on sporting organisations and clubs, leagues, gyms and fitness centres, athletes, coaches, staff, and sport-related business, including sports event organisers and sports media; considers that the road to recovery will be challenging and underlines the need for targeted relief measures' (*ibid.*, at 18).

MEPs do not limit themselves to expressions of compassion but go on to underline that 'general recovery instruments adopted by the EU in response to the crisis must help support the sports sector in the short term and urges Member States to ensure that national support funds, the structural funds, and national recovery and resilience plans benefit the sports sector despite its specific characteristics and organisational structures' (*ibid.*, at 19).

This passage is of particular importance, as EU funds disbursed nationally or regionally (e.g. agricultural, regional, structural funds) have not always been good at reaching the most needy people, while priority has often been given to infrastructure projects (European Parliament, 2016). In some Member States, they may even have served to counteract deinstitutionalisation, to prevent an otherwise natural transition towards independent living for disabled people. The EP research service has summarised evidence from the last decade on the 'inappropriate use of EU Funds to maintain institutional care,' recording 'significant concerns' raised about the 'investment of such funds into institutional care' by 'civil society organisations since 2007' (*ibid.*, p. 31). The Council of Europe Commissioner for Human Rights is on record for having complained, in 2014, that some Member States were still 'refurbishing existing institutions or even building new ones – sometimes, shamefully, with EU structural funds' (*ibid.* p. 31). The

EP report includes detailed examples from several (not only 'new', post-2004, Member States (*ibid.* pp. 32-33), while also pointing to the risk of a 'replication of institutional care in community-based settings' (*ibid.* p. 34): again facilitated by EU funding. Of course, such projects are easier to control and to audit, yet independent living in the community is a far better way to ensure compliance with Article 19 CRPD (UN Convention on the Rights of Persons with Disabilities) (*ibid.* p. 14). Similarly, structural funding disbursed in Hungary has been accused of having strengthened the Fidesz party precisely at a time when the EU is concerned about its 'illiberal democracy' agenda (Ash 2014). If the management of 'Next Generation EU' funds is to be decentralised, then the very least that MEPs can do is to define the desired policy outcomes in a legislative resolution, which is what they have done.

Parliament goes on to stress 'the importance of rescue packages targeting all sports; highlights that while major spectator sports have often been the hardest hit financially, they should not be the only ones to qualify for financial aid or be given priority for it' (European Parliament 2021, at 20), while anticipating 'that existing financial support may not be sufficient and calls on the Commission to explore all possible avenues for delivering additional targeted support for both amateur and professional sports with the aim of increasing the viability of the whole sector' (*ibid.*, at 21). MEPs finally call on the Commission and the Member States 'to strengthen the recovery and crisis resilience of the sports sector in general, and grassroots sport in particular, through the EU programmes available and for which the sector is eligible, including the Erasmus+ programme and the European Solidarity Corps, and to ensure full access for sport to the Recovery and Resilience Facility, the European Regional Development Fund, the Cohesion Fund, the European Social Fund Plus and EU4Health; underlines that the incorporation of sport into the respective regulations and the removal of all obstacles in the application process at national level are key in this regard' (*ibid.*, at 22).

Whether Parliament's expectations will be fulfilled, depends on Member States and the action plans through which they will use their European recovery funds. While these are early days and indeed, and the actual use of funds can only be evaluated further down the road, some intermediary research findings reported by the RAY Network (Research-based Analysis and Monitoring of European Youth Programmes) (https://www.researchyouth.net), an initiative of currently 34 National Agencies of the Erasmus+ Youth in Action & European Solidarity Corps programmes, suggest that there is ample reason to keep an eye on developments in this field. Having already looked into young people's experience of the pandemic, and societal response to it, at an early stage (RAY Network 2020), a team of researchers more recently focused on implications for the financial and other conditions under which youth work is to be delivered

(RAY Network 2021). Recalling that the pandemic 'has shaken – and keeps shaking – youth work to its core,' they warned that its economic effects 'are severe – and keep increasing' (*ibid.*, slide 15); while youth work 'needs massive support' (*ibid.*, slide 17), not least because much of the offer is project based (as opposed to funded through long-term operating grants). The RAY researchers recommended that: 'Recovery should be achieved, and the resilience of the Union and its Member States enhanced, through the support for measures that refer to the policy areas of European relevance structured in six pillars (the "six pillars"), including Policies for the next generation.' (RAY Network 2021, slide 18)

In this connection, they thought that: 'Member States should explain how the plan will promote policies for the next generation […] Actions should ensure that the next generation of Europeans is not permanently affected by the impact of the COVID-19 crisis and that the generational gap is not further deepened.' (RAY Network 2021, slide 19). To this end, the RAY researchers have so far examined the national action plans of Belgium, France (23 June), Italy, Germany, Latvia (22 June), Slovakia, Austria (21 June), Luxembourg (18 June), Greece, Denmark (17 June), Portugal and Spain (Ray Network 2021, slide 22). Within this sample, the found 10 plans with youth actions in the areas of Education, Employment, Entrepreneurship, Transition education employment and Transition education entrepreneurship (*ibid.*, slide 23). They identified just 2 plans with youth work actions, either through 'Subsidies for employment of young people in the non-profit sector (somewhat indirect)' or in the shape of 'Renovations of youth houses (as part of a larger action to renovate education spaces)' (*ibid.*, slide 24); while they also warned that 'more may be hidden in details not submitted to the Commission (for implementation) (16 June)' (*ibid.*, slide 24). The prima facie conclusion was the youth work seemed to be 'falling through the cracks' and that, 'without dedicated action, we are undermining the basis of the programmes' (RAY Network 2021, slide 25).

In re-reporting these insights gained from the research performed by the RAY Network, we should emphasise that this represents just one perspective on national action plan proposed by Member States in one particular area of policy and practice. On the other hand, the views of researchers representing 34 National Agencies of the Erasmus+ Youth in Action & European Solidarity Corps programmes, with expertise not only as regards the lives of young people but also of Member States' use of EU funding, cannot be dismissed easily. On balance, if there is reason to keep an eye on developments in the field of youth, the same will definitely apply to its sister policy area sport. On the other hand, sceptics may opine that the expectations of Parliament, as laid out above, have no legal value. The extent to which these expectations are a force to be reckoned with is the subject of the next section of this paper.

Enforceable requirements?

Legal acts of the European Union fall into two categories: binding hard law and non-binding soft law (fundamentally: Terpan 2015; Craig & de Búrca 2021, p. 110). Soft law encompasses 'a variety of non-binding soft-law arrangements' including Council Recommendations, Memoranda of Understanding (MoUs), etc. (Craig & de Búrca 2021, p. 245); these are particularly frequent in the context of EU agencies where they are referred to under the concept of 'agentification' (*ibid.*, p. 244). Many high-profile EU initiatives are based partly on soft law, such as the rule of law framework (*ibid.*, p. 437); or entirely, as in the case of the European Semester (*ibid.*, p. 441). That soft law texts are not legally binding, does not deprive them of any legal relevance, as they may serve to interpret hard law (*ibid.*, p. 341), including even before national courts (Korkea-aho 2018). And according to one authoritative economist with an interest in regulatory matters, the EU may have reached more in terms of effective, consumer-friendly market regulation (and certainly more than the US) through 'name and shame' than through mere regulation (Philippon 2019, p. 136), although EU regulators additionally benefit from more independence than their US counterparts (*ibid.*, p. 136). According to this theory of political economy, the EU got its 'fiercely independent institutions precisely because this was required to get all countries on board (*ibid.*, p. 148), when (applying game theory) national politicians would rather forego the chance to 'capture' these common institutions than let other countries do so (*ibid.*, p. 142). Although this entailed a 'bias towards independence (*ibid.*, p. 142), it all wouldn't have worked so well without a dose of soft law. This insight assumes a particular salience in light of the EU's role as a global regulator in such fields as antitrust law, data protection and chemicals regulation asserted through ground-breaking empirical legal research (Bradford 2020). Within the sport policy field, EC/EU action has always represented a mixture of hard law and soft law though, realistically, the credibility of soft law measures has probably been enhanced by the possibility of hard law interventions, even if no recourse was made thereto (Kornbeck 2006). Parallel to the explicit, soft-law based HEPA policy of the EU, an implicit, hard-law based variant is recognisable, grounded in antitrust and state aid law, etc. (Kornbeck 2018); although there is reason to question the effectiveness of the explicit, soft-law based brand of HEPA policy (Kornbeck 2021).

Whereas the Union and its Member States may regard recovery in other policy areas – perceived as less 'soft' and more 'core' – as more pressing than HEPA recovery, and while they can be expected to dismiss their EU soft law commitments as secondary their hard law equivalents, it is our intention to ground our discussion in EU soft law commitments relevant to HEPA promotion. These commitments are derived from a process unfolding around 2004, with the

publication of an externally commissioned structured review of raising physical inactivity and increased overweight and obesity in children and young people (Brettschneider & Naul 2005), which was followed up by a range of academic publications (e.g. Brettschneider & Naul 2007) and which triggered the development of specific methodologies regarding multi-actor intervention projects in local communities (Brettschneider, Hoffmann, Naul & Steinzen 2009; Naul, Kornbeck & L'Hoir 2010; Naul, Schmelt, Dreiskaemper, Hoffmann & L'Hoir 2012). This mixture of EU research and project funding, coupled with an increased policy coordination activity within various EU working groups as well as within the relevant EU-level decision-making bodies (informal meetings of Member States' Sport Directors and Sport Ministers and later, after the entry into force of the Lisbon Treaty with its Article 165 TFEU enlarged to encompass sport and allow the Union to adopt non-binding Council texts in that policy field). Taking its clues from the non-binding 2008 EU HEPA Guidelines, adopted by Member States' Sport Ministers in Biarritz under French EU Presidency (European Commission 2008), these efforts ultimately paved the way for a specific EU HEPA policy (Naul 2018) based on Article 165-derived soft law (Kornbeck 2018) and finding its culmination, so far, in the 2013 Council HEPA Recommendation (Council of the European Union 2013) (Council recommendations being the highest level of EU soft law and thus bordering on EU hard law). Thus, EU soft law commitments – even obligations – regarding HEPA promotion have been in place for eight years, even if their non-binding nature may work against them. Critics may opine that soft law is no law at all. This is the legal opinion of Manuel Medina Ortega, law professor an MEP, insisting that 'under international law, States cannot be bound against their will' (Medina Ortega 2012, p. 194), while considering soft law a misnomer attributing to certain legal acts 'a normative value which they cannot possess' (*ibid.*, p. 196). On the other hand, even soft law norms may acquire a highly committing quality, as acknowledged by the Court of Justice, in 2021, in *Germany v Poland*, on appeal from the General Court, a trial concerning the (in)compatibility of the Nordstream 2 pipeline with the EU's so-called 'energy solidarity' (Article 194(1) TFEU). The Court struck down Germany's allegation that 'the principle of energy solidarity could at most be binding on the EU legislature, and not on the Commission as the executive body,' considering instead that it, 'like general principles of EU law, constitutes a criterion for assessing the legality of measures adopted by the EU institutions' (Court of Justice of the European Union 2021, paragraph 45). The Court exposed the opportunistic character of the German allegation through a cross-reference to its jurisprudence on the refugee distribution, in which Germany had very well ascribed binding legal effects to a legal act disputed by the four Visegrad countries, adjudicated in 2017

and again in 2020. The 'allegedly abstract nature of the principle of solidarity,' invoked by Germany to avoid the obligations of energy solidarity, could not be upheld for the very same reasons why the Visegrad countries could not escape their obligations to receive refugees (*ibid.*, paragraph 42).

As noted elsewhere in more detail and with a more exclusively legal focus (Kornbeck 2021), the policy process based on the 2013 Council HEPA Recommendation is potentially flawed because of its reliance on self-reporting by Member States. An analysis of the first (European Commission 2016) and second implementation reports (European Commission 2019), elaborated by the Commission at the request of the Council and covering the periods of 2013-16 and 2016-19, respectively, reveals a traffic-light monitoring system which seems skewed towards positive reporting, as it has produced far more green than red lights (Kornbeck 2021), even though recent Eurobarometer surveys have continued documenting a steady decrease in sport and physical activity practice across the Union (most recently: European Commission 2018). One of the key principles enshrined in the 2018 EU HEPA Guidelines is that funding should not be reserved for specific legal entities, but rather for specific activities, another being that policies should be evidence-based (Kornbeck 2020). The distinction between funding earmarked for legal entities, as opposed to funding directed towards defined activities on the basis of explicit, verifiable and evaluable policy objectives, in a significant one although, sadly, most national sport policies still seem to follow the traditional entities-led model (*ibid.*).

Against this backdrop, a European Parliament Resolution spelling out specific expectations regarding the use of specific budget allocations is worthy of a good deal of attention. The EP has always cherished its 'power of the purse', especially during those long decades, following the introduction of direct elections (1979), when its powers in other areas were rather meagre. 'However constrained and mitigated,' Parliament always took its budgetary power 'most seriously,' and it was 'one through which it has endeavoured to extend its political influence,' as noted by the former EP Secretary General Sir Julian Priestley (1950-2017) and his co-author, an EP official (Clark & Priestley 2012, p. 273). 'Sure enough, one of its first acts upon acquiring full budgetary powers' in 1979 was 'to reject the annual budget of the (then) European Economic Community for 1980,' triggering a politico-institutional crisis. 'Subsequently, as is their wont, the Community institutions found a way to overcome the crisis in relatively short order,' but from the on, the Council and the Commission 'began to learn the hard way that the Parliament would be no pushover when it came to the budget' (*ibid.*, p. 273). The budget became a 'field for big beasts' (*ibid.*, p. 274) and its main actors came to be revered as part of a 'budgets pantheon' (*ibid.*, p. 275). 'The art form of the all-nighter has been perfected in the Committee on

Budgets' (*ibid.*, p. 291). From then on, for the Commission (but also for the Council), the 'establishment of a strong bond with Parliament mattered' (van der Harst & Voerman 2015 p. 184). But following a period of 'budgetary battles' (1979-88), a style of more 'ordered budgetary decision-making' (1988+) established itself (Laffan & Lindner 2010, pp. 215-218), while managing an increased budget has led to more consensual policy styles over time (*ibid.*, pp. 224-225). Up until the pandemic and introduction of the post-Covid-19 recovery funds, 'small size of the EU budget' persisted as a 'key characteristic of the finances of the Union,' creating a 'mismatch between the expenditure priorities' of the Union and the 'key policy priorities facing Europe' (*ibid.*, p. 277).

This assessment, however, is up for a profound reappraisal, as the surprising adoption of the 'Next Generation EU' financial instruments broke with precedent in at least two respects: by virtue of sheer size (€ 750 bn in total) and, perhaps even more epochally, by providing for funds to be raised on international lending markets, effectively introducing a public debt service of the Union (where there was none between 1952 and 2021) and by mutualising this Union debt (indeed a red line, until then, for many net-contributors among Member States). While it is premature to gauge the further effects of this sea-change upon the integration process, the burden-sharing and power-patterns between Union and Member States and, indeed, the expected knock-on effects on economic growth and societal well-being, this is an entirely novel situation, and Parliament's budgetary powers may be expected to play a key role in defining political priorities regarding the disbursement of funds allocated by the co-legislators (Parliament and Council). Against this backdrop, expectations defined by MEPs and enshrined in EP resolutions should be worthy of a good deal of attention.

Conclusion

In their recent study commissioned by the European Parliament, Mittag & Naul (2021) were quite upbeat in their assessment of progress made in promoting HEPA prior to the pandemic: 'Physical education has been upgraded on the EU sports policy agenda as a result of the growing dominance of HEPA policy initiatives (White Paper on Sports 2007; EU-Physical Activity Guidelines 2008; Council Recommendation on HEPA 2013; monitoring of the EU Physical Activity Guidelines 2016 and 2019) for about a decade after the last EP study in 2007.' (*ibid*., p. 67).

Yet they were far less sanguine about the state of affairs during the pandemic, or indeed the prospects for a post-pandemic HEPA recovery: 'The impact of COVID-19 on regular physical education at school and physical activity after closure of grassroots sport clubs across the majority of Member States is currently being researched by scholars. The COVID-19 pandemic changed the lifestyle behaviours of many young Europeans to more sedentary activities, and a concerning decline of regular physical activities. Many former European promotion initiatives of HEPA and grassroots sport participation were put on hold or even scaled-down due to the pandemic, leaving youth at even greater risk of establishing inactive lifestyles, as well as social isolation and behavioural problems in family life. Therefore, a COVID-Recovery Fund (CRF) on school-based HEPA and local sport club-based physical activities is necessary to adopt and rebuild the foundations of healthy active lifestyles among young people in the post-COVID era.' (*ibid*., p. 85).

While this assessment seems more than ordinarily plausible, it nevertheless needs to be assessed against the available knowledge, and the findings from such an exercise will need to be in-fused into a debate grounded in EU law and policy, with a view to ascertain to what extent the EU can (and indeed should) make a significant contribution to the necessary post-pandemic HEPA recovery. Parliament's expectations as expressed in the Resolution discussed earlier in this paper European Parliament (2021) might have more legal relevance in practice than might be assumed prima facie. If the observations made by RAY researchers regarding national action plans and their relevance to youth work (RAY Network 2021) are to be supported then, by extension, it seems reasonable to infer that in relation to sport, as well, there is every reason to watch the emerging practice of spending European funds allocated from financial instruments aimed at post-pandemic recovery. The impact of the pandemic on sport has been profound (Grix, Brannagan, Grimes & Neville 2021), though it has been cushioned somewhat through measures such as tax breaks and bailouts (Ličen 2020) which, however, seem rather to have benefited competitive sport, whether professional or not, than community sport, sport for all and HEPA. Ensuring sufficient funding for sport and physical activity offers for the entire population should be a priority, too, especially when public funds available have reached such unprecedented levels as they now have.

References

1. ASH, T. G., 2019. Europe must stop this disgrace: Viktor Orbán is dismantling democracy. *The Guardian*, Thu 20 Jun 2019 06.00 BST, https://www.theguardian.com/commentisfree/2019/jun/20/viktor-orban-democracy-hungary-eu-funding.
2. BRADFORD, A., 2020. *The Brussels Effect: How the European Union Rules the World.* Oxford: Oxford University Press.
3. BRETTSCHNEIDER, W. D., D. HOFFMANN, R. NAUL & A. STEINZEN, 2009. Von den Erkenntnissen aus dem EU-Bericht „Young people`s lifestyle and sedentariness" zur handlungsorientierten Umsetzung der Empfehlungen im Rahmen von zwei lokalen Präventionsstudien. In: Naul, R.; Krüger, A. & Schmidt, W. (eds) *Kulturen des Jugendsports. Bildung, Erziehung und Gesundheit*. Aachen: Meyer & Meyer, 67-104.
4. BRETTSCHNEIDER, W. D. & R. NAUL, 2005. *Study on young people's lifestyles and sedentariness and the role of sport in the context of education and as a means of restoring the balance. Study for the European Commission*. Paderborn: University of Paderborn. http://www.uni-muenster.de/imperia/md/content/sportwissenschaft/eu-studies/abstracts/noored_ja_sport_04_lotpaderborn.pdf.
5. BRETTSCHNEIDER, W.D. & R. NAUL (Hrsg.), 2007. *Obesity in Europe: young people's physical activity and sedentary lifestyles.* Frankfurt/Main: Peter Lang.
6. CLARK, S. & J. PRIESTLEY, 2012. *Europe's Parliament: people, places, politics*. London: John Harper Council of the European Union (2013) Council Recommendation of 26 November 2013 on promoting health-enhancing physical activity across sectors. JO C 354 du 4.12.2013, p. 1–5.
7. COURT OF JUSTICE OF THE EUROPEAN UNION, 2021.. Judgment of the Court (Grand Chamber) of 15 July 2021. Federal Republic of Germany v European Commission. Case C-848/19 P. (Appeal Case before the General Court T-883/16). ECLI:EU:C:2021:598.
8. CRAIG, P. & G. DE BÚRCA, 2021. *The Evolution of EU Law. Third Edition*. Oxford: OUP.
9. EUROPEAN COMMISSION, 2008. Brussels, 10 October 2008. EU Physical Activity Guidelines. Recommended Policy Actions in Support of Health-Enhancing Physical Activity. Approved by the EU Working Group "Sport & Health" at its meeting on 25 September 2008. Confirmed by EU Member State Sport Ministers at their meeting in Biarritz on

27-28 November 2008. https://ec.europa.eu/assets/eac/sport/library/policy_documents/eu-physical-activity-guidelines-2008_en.pdf.

10. EUROPEAN COMMISSION, 2016. Report from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions on the implementation of the Council Recommendation on promoting health-enhancing physical activity across sectors. Brussels, 5.12.2016. COM(2016) 768. https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52016DC0768&from=HU.
11. EUROPEAN COMMISSION, 2018. Special Eurobarometer 472 – Wave EB88.4 – TNS opinion & social. Sport and physical activity. Fieldwork December 2017. Publication March 2018. https://europa.eu/eurobarometer/surveys/detail/2164.
12. EUROPEAN COMMISSION, 2019. Report from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions on the implementation of the Council Recommendation on promoting health-enhancing physical activity across sectors. Brussels, 6.11.2019. COM(2019) 565. https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2019:0565:FIN:EN:PDF.
13. EUROPEAN PARLIAMENT, 2016. European Structural and Investment Funds and People with Disabilities in the European Union, PE 571.386 (2016), https://www.europarl.europa.eu/RegData/etudes/STUD/2016/571386/IPOL_STU(2016)571386_EN.pdf.
14. EUROPEAN PARLIAMENT, 2021. B9-0115/2021. European Parliament resolution on the impact of COVID-19 on youth and on sport (2020/2864(RSP)). https://www.europarl.europa.eu/doceo/document/TA-9-2021-0045_EN.html.
15. GARCÍA, B., A. VERMEERSCH & S. WEATHERILL, 2017. A new horizon in European sports law: the application of the EU state aid rules meets the specific nature of sport. *European Competition Journal.*13:1, 28-61.
16. GRIX, J.; P. M. BRANNAGAN, H. GRIMES & R. NEVILLE, 2021. The impact of Covid-19 on sport. International *Journal of Sport Policy and Politics.* 13:1, 1-12.
17. KORKEA-AHO, E., 2018. National courts and European Soft Law: Is Grimaldi Still Good Law? *Yearbook of European Law.* **37**, 470-495.
18. KORNBECK, J., 2006. Governance als Soft Law: Innovation oder Notwendigkeit im sportpolitischen Handeln der EU? In: Tokarski, W.; Petry, K. & Jesse, B. (eds) *Sportpolitik. Theorie- und Praxisfelder von Governance im Sport*. Cologne: Sportverlag Strauß (Veröffentlichungen der Deutschen Sporthochschule Köln; 15), pp. 31-52.

19. KORNBECK, J., 2018. Health-friendly sport policy: an emerging soft law doctrine. In: Anderson, J.; Parrish, R. & García García, B. (eds) *Research Handbook on EU Sports Law and Policy*. Cheltenham: Edward Elgar, pp. 49-78.
20. KORNBECK, J., 2019. HEPA as "le geste sportif"? Structures versus activities in public policies for the promotion of sport and health-enhancing physical activity (HEPA). In: Scheuer, C. & Dreiskämper, D. (eds) *Schola Ludens Europaeus: papers offered to Roland Naul*. Aachen: Meyer & Meyer Verlag, pp. 183-205.
21. KORNBECK, J., 2020. Modèles économiques de la politique sportive : pour valoriser le sport politiquement, juridiquement et financièrement, faut-il cibler les entités ou les activités ? *Annales de la Faculté de Droit d'Istanbul*, 69, 227-246.
22. KORNBECK, J., 2021. Droit dur ou droit mou ? L'Union européenne et la promotion des APS. *Jurisport*. 216, 39-41.
23. LAFFAN, B. & J. LINDNER, 2010. The Budget: who gets what, when and how? In: Wallace, H.. Pollack, M.A. & Young, A.R. (eds) *Policy Making in European Union. 6th ed.* Oxford: Oxford University Press, 2014, pp.207-228.
24. LIČEN, S., 2020. Bailouts and Tax Breaks: Slovenian Olympic Committee's Communication During Covid-19. In: Pedersen, P.M.; Ruihley, B.J. & Li, B. (eds) *Sport and the Pandemic: Perspectives on Covid-19's Impact on the Sport Industry*. London: Routledge, pp. 137-145.
25. MEDINA ORTEGA, M., 2012. Soft law et principes démocratiques. In: Peraldi Leneuf, F., et al. (eds) *La légistique dans le système de l'Union européenne : quelle nouvelle approche ?* Brussels: Bruylant, pp. 191-204.
26. MITTAG, J. & R. NAUL, 2021. *EU sports policy: assessment and possible ways forward. Research for CULT Committee.* Brussels: Policy Department for Structural and Cohesion Policies. PE 652.251. https://www.europarl.europa.eu/cmsdata/236742/PE652-251_Study-EU-Sport-Policy.pdf.
27. NAUL, R., 2018. Die EU-Guidelines for Physical Activity: Entwicklung und Bedeutung? In: Mittag, J. (ed) *Europäische Sportpolitik. Zugänge – Akteure – Problemfelder*. Baden-Baden: Nomos, 271-286.
28. NAUL, R., J. KORNBECK & M. L'HOIR, 2010. Multi-actor Strategies of Health-Enhanced Physical Activities for Children in Local Communities of the European Union. *Medicine and Science in Sports and Exercise*, 42:5, 361.

29. NAUL, R., J. KORNBECK & S. PETKOVIC, 2021. Young Europeans as Covid-19 Couch Potatoes? Physical Activity/Physical Education Rollback Caused by Covid-19-related Developments. [Paper abstract]. In: Smokvina, Vanja; Parrish, Richard; García García, Borja; Lindholm, Johan; McArdle, David & Cattaneo, Andrea (eds) *15th Sport&EU Conference Book of Proceedings*. Rijeka: University of Rijeka, Faculty of Law, p. 37.
30. NAUL, R., D. SCHMELT, D. DREISKAEMPER, D. HOFFMANN & M. L'HOIR, 2012. 'Healthy children in sound communities' (HCSC/gkgk): a Dutch–German community-based network project to counteract obesity and physical inactivity. *Family Practice*, 29 (suppl 1), i110-i116.
31. PHILIPPON, T., 2019. *The Great Reversal: How America Gave Up on Free Markets*. Cambridge, MA: Belknap Press.
32. RAY Network, 2020. Policy Brief 09/2020: Youth Work and the Pandemic in Europe, https://www.researchyouth.net/wp-content/uploads/2020/09/RAY-COR_Policy-Brief-September_20200915.pdf.
33. RAY Network, 2021. Network updates – and sneak peek on most recent research findings (NA meeting): "RAY COR" project. Presentation (slideshow) from a meeting of Erasmus+ National Agencies, 28 June 2021 (on file with author).
34. VAN DER HARST, J. & G. VOERMAN, 2015. *An Impossible Job? The Presidents of the European Commission, 1958-2014*. London: John Harper Publishing.
35. TERPAN, F., 2015. Soft Law in the European Union-The Changing Nature of EU Law. European Law Journal, 21:1, 68-96.
36. VAN DEN BROEK, O., 2021. Soft Law Engagements and Hard Law Preferences: Comparing EU Lobbying Positions between UN Global Compact Signatory Firms and Other Interest Group Types. Business and Politics, 23:3, 383-405.