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Research article

The Total Work Measured During a High Intensity Isokinetic Fatigue Test Is Associated With Anaerobic Work Capacity

Laurent Bosquet [1, 2]✉, Kenan Gouadec [2], Nicolas Berryman [1, 3, 4], Cyril Duclos [5, 6], Vincent Gremeaux [7, 8] and Jean Louis Croisier [9]

[1] Laboratory MOVE (EA6314), Faculty of Sports Science, University of Poitiers, Poitiers, France; [2] Department of Kinesiology, Université de Montréal, Montreal, Canada; [3] Department of Sport Studies, Bishop's University, Québec, Canada ; [4] National Institute of Sport, Montréal, Canada; [5] Laboratory of Pathokinesiology, Center for Interdisciplinary Research in Rehabilitation, Montreal, Canada; [6] School of Rehabilitation, Faculty of Medicine, Université de Montréal, Montreal, Canada; [7] Plateforme d'Investigation Technologique, Centre Hospitalier Universitaire, Dijon cedex, France; [8] Faculty of Sport Sciences, University of Bourgogne, Dijon cedex, France; [9] Department of Motricity Sciences, University of Liege, Belgium

Abstract

The purpose of the study was to determine whether total work measured during a high intensity isokinetic fatigue test (TW_{FAT}) could be considered as a valid measure of anaerobic work capacity (AWC), such as determined by total work measured during a Wingate Anaerobic Test (TW_{WAnT}). Twenty well-trained cyclists performed 2 randomly ordered sessions involving a high intensity isokinetic fatigue test consisting in 30 reciprocal maximal concentric contractions of knee flexors and extensors at 180°·s^{-1}, and a Wingate Anaerobic Test. We found that TW_{FAT} of knee extensors was largely lower than TW_{WAnT} (4151 ± 691 vs 22313 ± 2901 J, respectively, $p < 0.05$, Hedge's g = 4.27). Both measures were highly associated (r = 0.83), and the 95% limits of agreement (LoA) represented 24.5% of TW_{WAnT}. TW_{FAT} of knee flexors (2151 ± 540 J) was largely lower than TW_{WAnT} ($p < 0.05$, g = 9.52). By contrast, both measures were not associated (r = 0.09), and the 95% LoA represented 31.1% of TW_{WAnT}. Combining TW_{FAT} of knee flexors and knee extensors into a single measure (6302 ± 818 J) did not changed neither improved these observations. We still found a large difference with TW_{WAnT} ($p < 0.05$, g = 5.26), a moderate association (r = 0.65) and 95% LoA representing 25.5% of TW_{WAnT}. We concluded that TW_{FAT} of knee extensors could be considered as a valid measure of AWC, since both measure were highly associated. However, the mean difference between both measures and their 95% LoA were too large to warrant interchangeability.

Key words: Isokinetic dynamometry, muscle fatigue, Wingate anaerobic test, cyclists, physiological assessment

Introduction

Isokinetic dynamometry is classically used to assess neuromuscular function through different parameters such as peak torque, total work or the peak torque ratio between agonist and antagonist muscles (Croisier, 2004; Gleeson and Mercer, 1996). The assessment of muscle bioenergetics with this kind of dynamometry is less common. Such an approach requires experimental data to warrant both the reliability and the validity of measures obtained during a specific protocol. We previously examined the effect of the lengthening of a high intensity isokinetic fatigue protocol (20 to 50 reciprocal maximal concentric contractions at an angular velocity of 180°·s^{-1}) on the relative and absolute reliability of fatigue measures (Bosquet et al., 2010). We concluded that total work measured during a protocol involving 30 reciprocal maximal concentric contractions represented a good compromise between reliability (intraclass coefficient of correlation = 0.91 and standard error of measurement = 4%) and bioenergetical interpretability of the data. In fact, the mean duration of the test (approximately 40 seconds) fulfils current recommendations for the assessment of anaerobic work capacity (AWC) (Green, 1995). Anaerobic work capacity is defined as the total amount of work performed during an exhaustive work bout underpinned by a relatively high ATP yield (Green, 1995). Since it represents a major contributor to success in events during which anaerobic capacity is nearly completely depleted, such as the 800 m in running (Spencer and Gastin, 2001), it is important for sport scientists to provide athletes and coaches with accurate estimates of this parameter. Although there exists no gold standard per se, the total work performed during a 30 – second Wingate anaerobic test (WAnT) is often considered as one of the best indicators of this ability (Green, 1995; Vandewalle et al., 1987). Several studies have already reported a close association ($0.52 < r < 0.96$) between peak or mean power during a WAnT and peak or mean torque during an isokinetic fatigue test in moderately trained participants (Brown et al., 1994; Patton and Duggan, 1987; Smith, 1987). However, none of them examined the agreement between total work performed in both tests by cyclists of national performance capacity. Therefore, the purpose of this study was to determine the validity of total work measured during our optimized high intensity isokinetic protocol to assess AWC, and whether it could be used interchangeably with total work measured during WAnT. Given the nature of the tasks (i.e. mono vs multi-joint exercises) and the type of muscular work (i.e. isoinertial vs isokinetic), we hypothesized that both measures would be associated, but could not be used interchangeably.

Methods

Experimental approach to the problem

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Following a thorough briefing and medical screening all participants signed a written statement of informed consent. Subsequently, they participated in 2 randomly ordered exercise test sessions involving a high-intensity isokinetic fatigue test of the knee (FAT), and a force-velocity test (FVT) immediately followed by a Wingate anaerobic test (WAnT). All tests were administered to all the participants by the same investigator, and were separated by at least 72h of recovery, within a 4-week period. To avoid any residual fatigue induced by a recent workout, participants were asked to refrain from strenuous exercise 48 h before the tests. The protocol was reviewed and approved by the Research Ethics Board in Health Sciences of the University of Montreal (Canada).

Participants

Twenty highly-trained male cyclists without prior history of knee injury volunteered to participate in this study. Their mean (SD) age, height, body mass and sum of skinfolds (triceps, biceps, subscapular and suprailiac) were 30.1 (6.2) years, 1.79 (.06) cm, 72 (8) kg and 28 (7) mm, respectively.

Exercise testing

High-intensity isokinetic fatigue test (FAT): The test was performed on a Biodex System III dynamometer (Biodex Medical Systems, Shirley, New York). A 5-minute warm-up period consisting in pedalling at 100 W with a cadence around 100 rpm was performed before the test. Thereafter, the participant was seated on the dynamometer seat, which was adjusted as previously described (Bosquet et al., 2010). We tested only the dominant leg, defined as the preferred kicking leg. The range of motion was 100° (0° corresponding to a full active extension). Before testing, all participants received the instruction of performing full range of motion during each contraction and to push up and pull down until they meet the stop provided by the isokinetic device. Familiarization with the dynamometer and the set-up included ten submaximal and progressively intensified concentric contractions (extension and flexion) at an angular velocity of $120°\cdot s^{-1}$. After a 2-min pause, participants were asked to perform 3 submaximal reciprocal concentric contractions at an angular velocity of $180°\cdot s^{-1}$. Afterwards, they performed 30 consecutive maximal reciprocal concentric contractions at an angular velocity of $180°\cdot s^{-1}$. Participants were encouraged to push/pull as hard and as fast as possible and to complete the full range of motion. Strong verbal encouragements were given throughout the test to motivate participants to develop maximal contraction during each repetition (McNair et al., 1996). Total work (J) performed during the entire range of motion of each repetition was computed using the device's software, and summed to obtain FAT total work (TW_{FAT}, in J). We previously showed that this measure was very highly reliable for knee extensors (ICC = 0.91) and highly reliable for knee flexors (ICC = 0.75) (Bosquet et al., 2010).

Force-velocity (FVT) and Wingate anaerobic (WAnT) tests: These tests were performed on an electro-magnetically-braked cycle ergometer (Excalibur, Lode B.V., Groningen, The Netherlands) with automatic pedals (i.e. toe strap pedals that allow development of power during the whole revolution). Saddle and handlebar height as well as forward placement were adjusted at the beginning of the session to determine optimal position. Participants completed a 7-min warm-up period at 100 W with a cadence around 100 rpm. Thereafter they performed a set 3 sprints of 6 seconds at 0.7, 0.8 and 0.9 $Nm\cdot kg^{-1}$ of body mass, interspersed by 54 seconds of passive recovery. A 5-minute rest period was allowed before FVT. This test consisted in several 6-second sprints against increasing load, interspersed with 5-minute periods of recovery. Initial resistance was set at 0.9 $Nm\cdot kg^{-1}$ and increased by 0.1 $Nm\cdot kg^{-1}$ until power output decreased during two consecutive sprints. The highest power output observed during the test was considered as FVT peak power output ($PPO_{FVT,}$ in W). A 10-minute rest period was allowed between FVT and WAnT. Thereafter workload was set at the resistance that allowed reaching PPO_{FVT} and the test was executed according to standard instructions (Inbar et al., 1996). Verbal encouragement was given up to the end of the test. The highest power output observed during the test was considered as WAnT peak power output (PPO_{WAnT}). Mean power output over the test was also computed (MPO_{WAnT}), and converted in cumulated total work by multiplying it by 30 (TW_{WAnT}). This latest measure was considered as the reference measure for AWC (Green, 1995)

Statistical analysis

Standard statistical methods were used for the calculation of means and standard deviations. Normal Gaussian distribution of the data was verified by the Shapiro-Wilk test, and homoscedascticity by a modified Levene Test. All variables met these underlying hypotheses. A paired t-test was used to test the null hypothesis that there was no difference between parameters measured during FAT and WAnT. The magnitude of the difference was assessed by the Hedges g (g), as presented elsewhere (Dupuy et al., 2014). The scale proposed by Cohen (Cohen, 1988) was used for interpretation. The magnitude of the difference was considered either small ($0.2 < g \leq 0.5$), moderate ($0.5 < g \leq 0.8$), or large ($g > 0.8$). Pearson product moment correlation and the level of agreement (Ludbrook, 2010) were used to assess the association between relevant parameters. The scale by Munro (Munro, 1997) was used for interpretation. A correlation over 0.90 is as very high, between 0.70 and 0.89 as high and between 0.50 and 0.69 as moderate. Statistical significance was set at $p < 0.05$.

Results

Peak and mean power output measured during WAnT were 1415 ± 55 and 744 ± 97 W, respectively. Total work, which was considered as the reference measure for AWC, was 22313 ± 2901 J. The work accumulated during FAT by each muscle group (TW_{FAT}) and its comparison with TW_{WAnT} are presented in Table 1. TW_{FAT} of knee extensors was largely lower than TW_{WAnT} ($p < 0.05$, $g = 4.27$). Both measures were highly associated (Figure 1; $r = 0.83$, $p < 0.05$), and the 95% limits of agreement represented 24.5% of TW_{WAnT}. Similarly, TW_{FAT} of knee

Table 1. Comparison of total work (TW) measured during the high intensity isokinetic fatigue test (FAT) with TW measured during the Wingate anaerobic test (WAnT; 22313 ± 2901 J). Data are means (±SD).

	TW FAT (J)	Difference with TW WAnT (J)	Magnitude of the difference (Hedge's g) [c]	Level of association (r)	95% limits of agreement	
					(J)	(%) [d]
Knee extensors	4151 (691) [a]	18162 (2355) [b]	4.27	.83	5459	24.5
Knee flexors	2151 (540) [a]	20162 (2995) [b]	9.52	.09	6942	31.1
Combination	6302 (818) [a]	16011 (5451) [b]	5.26	.65	5680	25.5

[a] different from all other measures (p<0.05); [b] different from total work measured during WAnT (p < 0.05); [c] the magnitude of the difference was considered either small (0.2 < g ≤ 0.5), moderate (0.5 < g ≤ 0.8), or large (g > 0.8). [d] expressed in percentage of TW measured during WAnT

flexors was largely lower than TW_{WAnT} ($p < 0.05$, $g = 9.52$). By contrast, both measures were not associated (Figure 2; $r = 0.09$), and the 95% limits of agreement represented 31.1% of TW_{WAnT}. Combining TW_{FAT} of knee flexors and knee extensors into a single measure ($TW_{combined}$: 6302 ± 818 J) did not changed neither improved these observations, since we still found a large difference with TW_{WAnT} ($p < 0.05$, $g = 5.26$), a moderate association ($r = 0.65$, $p < 0.05$) and 95% limits of agreement representing 25.5% of TW_{WAnT}.

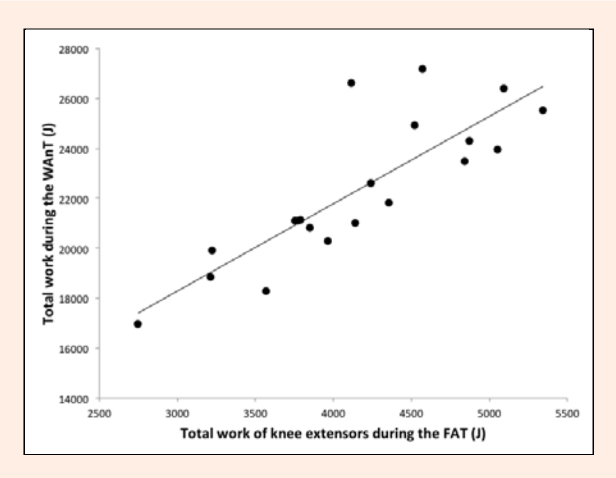

Figure 1. Relationship between total work measured during the Wingate anaerobic test or during the high intensity isokinetic fatigue test for knee extensors.

Discussion

A first purpose of this study was to determine whether TW_{FAT} could be considered as a measure of AWC in well to highly trained cyclists. In the absence of a gold standard, we considered the work accumulated during a 30-sec WAnT as the reference criterion for AWC (Green, 1995; Vandewalle et al., 1987). A second purpose was to determine whether TW_{FAT} and TW_{WAnT} could be used interchangeably. The statistical approach we opted for consisted in measuring the difference between TW_{FAT} and TW_{WAnT}, as well as their association and their 95% limits of agreement. Given the nature of the tasks (i.e. mono vs multi-joint exercises), we hypothesized that both measures would be associated, but could not be used interchangeably.

When considering performance level and training background of our participants, TW_{WAnT} measured in this study was in the range of expected values (Calbet et al., 2003; Withers et al., 1991). Given differences in the modes of exercise (isoinertial closed chain cycling vs isokinetic open chain knee flexion/extension) and in the muscle mass involved, it was not surprising to find a large difference between TW_{WAnT} and the TW_{FAT} of knee flexors and knee extensors. Since both muscle groups are contributing to performance during WAnT (a consequence of automatic pedals), we decided to combine their respective TW_{FAT} into a single measure ($TW_{combined}$). Although it largely increased TW_{FAT} ($p < 0.05$, $2.47 < g < 5.67$), we still found a large difference with TW_{WAnT}. The main reason for this residual difference was that performance in FAT involved knee extensors and flexors muscles of the dominant leg, when performance in WAnT involved ankle, knee and hip extensors and flexors of both legs. An alternative solution would have been to measure TW_{FAT} of both legs, as done by Brown et al. (1994). Nevertheless, they still found a large difference between both measures ($g > 2$).

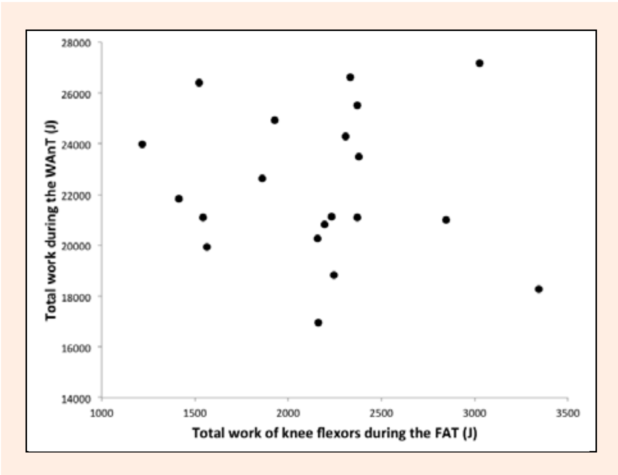

Figure 2. Relationship between total work measured during the Wingate anaerobic test or during the high intensity isokinetic fatigue test for knee flexors

In spite of the quantitative difference between both measures, we found a high correlation between TW_{FAT} of knee extensors and TW_{WAnT}, with a common variance of 69%. This close association allows establishing the validity of knee extensors TW_{FAT} as a measure of AWC, and is in agreement with previously published studies comparing peak or mean power during a WAnT and peak or mean torque during an isokinetic fatigue test in moderately trained participants ($0.52 < r < 0.96$) (Brown et al., 1994; Patton and Duggan, 1987; Smith, 1987). However, the magnitude of the 95% limits of agreement (24.5% of TW_{WAnT}) was too large to warrant interchangeability between both measures, particularly if we consider the large difference in means we previously discussed. Meaning of knee flexors data appeared questionable, since we found no association with TW_{WAnT} and large 95% limits of agreement (31.1% of TW_{WAnT}). This is an important result of the study, but it is difficult to provide a clear explanation of this observation. Several hypotheses have been proposed, including a lower reliability of knee flexors performance, or some neuromuscular phenomena that could be more detrimental to performance of this muscle group, including a specific interaction between motoneuron recruitment, rate of coding and co-contractions (Bosquet et al., 2010; Gleeson and Mercer, 1992; Maffiuletti et al., 2007). Although these explanations are receivable, we must recognize that there is no robust rational to justify why knee extensors should be less affected by these phenomena, by the exception of the intensity of reciprocal contractions. In fact, it is possible that knee flexors are probably not solicited to their maximum during isoinertial cycling, while they are during isokinetic testing. Whatever the exact origin of this noise, the absence of association is probably explained by the fact that knee flexors are not solicited to the same extent during FAT and WAnT. As expected, $TW_{combined}$ was negatively affected by the absence of association of knee flexor's TW_{FAT} with TW_{WAnT}, and did not add value to knee extensor's TW_{FAT} regarding the validity and interchangeability of the data.

The originality of this study was also to provide experimental data that could support a bioenergetical interpretation of the total work derived from a high intensity isokinetic fatigue test. Although it is highly associated to AWC, we previously showed that TW_{FAT} was also moderately associated to peak oxygen uptake (VO_2peak) (Bosquet et al., 2015). The common variance (34%) was very close from the ~35% predicted by Gastin (2001) for a maximal intensity exercise of 40 seconds. TW_{FAT} should therefore be considered as a composite measure that depends on both aerobic and anaerobic energy systems according to proportions that are determined by the duration of the test (~ 40 seconds). It should be kept in mind that this observation is not specific to FAT and also applies to WAnT. Granier et al. (1995) investigated aerobic and anaerobic contribution during a WAnT in sprint and middle-distance runners. Each population of participants used preferentially a metabolic system that depended on its speciality. In fact, mean aerobic contribution was 28±5% for sprint runners, and 45 ± 11% for middle-distance runners, which was very closed from the 30% predicted by the model of Gastin (Gastin, 2001). Independently of the metabolic reasons that subtend this difference, energy expenditure during a short-duration high-intensity test such as WAnT or FAT is therefore a mixture between aerobic and anaerobic pathways. An interesting perspective would be to assess the sentivity of TW_{FAT} to training induced changes, and to compare the predictive value of TW_{FAT} and TW_{WAnT} for athletic events with bionergetical characteristics that are close to those of these tests, such as the 400m in running.

Practical applications

Regarding the purpose of this study, we can conclude that TW_{FAT} of knee extensors can be considered as a valid measure of AWC, such as determined by TW_{WAnT}, but also that both measures can not be used interchangeably. Practically speaking, it means that those who perform higher quantities of work during FAT are likely to perform higher quantities of work during WAnT, but also that it is not possible to make a quantitative estimation of this improvement. Considering the difficulty to compare the performance of knee flexors during FAT and WAnT, it is not possible to provide a definitive answer to the question of the validity of TW_{FAT} of knee flexors to measure AWC. It is clear that both measures are not associated. However, there is no reason to exclude the possibility that TW_{FAT} of knee flexors provides a valid measure of AWC from this specific muscle group, and that $TW_{combined}$ provides a valid measure of AWC from the muscles of this specific joint. All together, our results suggest that sport scientists or practitioners may use a high intensity isokinetic fatigue test to assess AWC when it is not possible to implement a WAnT. Indeed, FAT is less time consuming than WAnT, and easier to perform and to repeat throughout a season. However, we also showed that results should be interpreted with nuance.

Conclusion

The purpose of this study was to determine whether the work accumulated during FAT could be considered as a measure of AWC during a multi-joint task such as the WAnT, and whether both measures could be used interchangeably. We concluded that TW_{FAT} of knee extensors could be considered as a valid measure of AWC, since both measure were highly associated. However, the 95% limits of agreement were too large to warrant interchangeability. The difficulty to compare the performance of knee flexors during FAT and WAnT did not allow to provide a definitive answer to the question of the validity of TW_{FAT} of knee flexors to measure AWC. This study has several practical implications for clinicians, particularly in the bioenergetical follow-up of athletes that should now be tested in training studies.

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References

Bosquet, L., Gouadec, K., Berryman, N., Duclos, C., Gremeaux, V. and Croisier, J.L. (2015) Physiological Interpretation of the Slope during an Isokinetic Fatigue Test. *International Journal of Sports Medicine* **36**, 680-683.

Bosquet, L., Maquet, D., Forthomme, B., Nowak, N., Lehance, C. and Croisier, J.L. (2010) Effect of the lengthening of the protocol on the reliability of muscle fatigue indicators. *International Journal of Sports Medicine* **31**, 82-88.

Brown, L., Whitehurst, M. and Buchalter, D. (1994) Comparison of bilateral isokinetic knee extension/flexion and cycle ergometry tests of power. *Journal of Strength and Conditioning Research* **8**, 139-143.

Calbet, J.A., De Paz, J.A., Garatachea, N., Cabeza de Vaca, S. and Chavarren, J. (2003) Anaerobic energy provision does not limit Wingate exercise performance in endurance-trained cyclists. *Journal of Applied Physiology* **94**, 668-676.
Cohen, J. (1988) *Statistical power analysis for the behavioral sciences*. Lawrence Erlbaum Associates, Hillsdale, NJ
Croisier, J.L. (2004) Factors associated with recurrent hamstring injuries. *Sports Medicine* **34**, 681-695.
Dupuy, O., Lussier, M., Fraser, S., Bherer, L., Audiffren, M. and Bosquet, L. (2014) Effect of overreaching on cognitive performance and related cardiac autonomic control. *Scandinavian Journal of Medicine and Science in Sports* **24(1),** 234-242.
Gastin, P.B. (2001) Energy system interaction and relative contribution during maximal exercise. *Sports Medicine* **31**, 725-741.
Gleeson, N.P. and Mercer, T.H. (1992) Reproducibility of isokinetic leg strength and endurance characteristics of adult men and women. *European Journal of Applied Physiology* **65**, 221-228.
Gleeson, N.P. and Mercer, T.H. (1996) The utility of isokinetic dynamometry in the assessment of human muscle function. *Sports Medicine* **21**, 18-34.
Granier, P., Mercier, B., Mercier, J., Anselme, F. and Préfaut, C. (1995) Aerobic and anaerobic contribution to wingate test performance in sprint and middle distance runners. *European Journal of Applied Physiology* **70**, 58-65.
Green, S. (1995) Measurement of anaerobic work capacities in humans. *Sports Medicine* **19**, 32-42.
Inbar, O., Bar-Or, O. and Skinner, J.S. (1996) *The Wingate Anaerobic Test*. Human Kinetics, Champaign
Ludbrook, J. (2010) Confidence in Altman-Bland plots: a critical review of the method of differences. *Clinical Experimental and Pharmacological Physiology* **37**, 143-149.
Maffiuletti, N.A., Bizzini, M., Desbrosses, K., Babault, N. and Munzinger, U. (2007) Reliability of knee extension and flexion measurements using the Con-Trex isokinetic dynamometer. *Clinical Physiology and Functional Imaging* **27**, 346-353.
McNair, P.J., Depledge, J., Brettkelly, M. and Stanley, S.N. (1996) Verbal encouragement: effects on maximum effort voluntary muscle action. *British Journal of Sports Medicine* **30**, 243-245.
Munro, B. (1997) *Statistical methods for health care research. Third edition*. Lippincott, New York
Patton, J.F. and Duggan, A. (1987) An evaluation of tests of anaerobic power. *Aviation and Space Environmental Medicine* **58**, 237-242.
Smith, D.J. (1987) The relationship between anaerobic power and isokinetic torque outputs. *Canadian Journal of Sports Science*. **12**, 3-5.
Spencer, M.R. and Gastin, P.B. (2001) Energy system contribution during 200- to 1500-m running in highly trained athletes. *Medicine and Science in Sports and Exercise* **33**, 157-162.
Vandewalle, H., Pérès, G. and Monod, H. (1987) Standard anaerobic exercise tests. *Sports Medicine* **4**, 268-289.
Withers, R.T., Sherman, W.M., Clark, D.G., Esselbach, P.C., Nolan, S.R., Mackay, M.H. and Brinkman, M. (1991) Muscle metabolism during 30, 60 and 90 s of maximal cycling on an air-braked ergometer. *European Journal of Applied Physiology* **63**, 354-362.

AUTHOR BIOGRAPHY

Laurent BOSQUET
Employment
Prof. at the Faculty of Sport Sciences and Director of the Laboratory MOVE, University of Poitiers, France
Degree
PhD
Research interests
Sports performance, physical activity prescription, heart disease, aging
E-mail: laurent.bosquet@univ-poitiers.fr

Kenan GOUADEC
Employment
Head coach of the Italian short track speed skating team.
Degree
MSc
Research interests
Sports performance, strength and conditioning, speed skating

Nicolas BERRYMAN
Employment
Adjunct professor at the department of sport studies, University Bishop, Canada
Degree
PhD
Research interests
Sports performance, mobility, aging, physical activity

Cyril DUCLOS
Employment
Adjunct Prof., Faculty of Medicine, Univ. of Montreal, Canada
Degree
PhD
Research interests
Interaction between proprioception and motor control, dynamic stability.

Vincent GREMEAUX
Employment
Professor at the faculty of medicine, University of Dijon, France ; Head of the rehabilitation departement, CHU of Dijon, France
Degree
MD, PhD
Research interests
Physical activity prescription, rehabilitation, exercise, eccentric

Jean Louis CROISIER
Employment
Professor at the department of motricity sciences, University of Liege, Belgium; Director of the department of motricity sciences, University of Liege, Belgium
Degree
PhD
Research interests
Isokinetics, eccentric, rehabilitation, prevention

Key points

- Total work performed during a high intensity isokinetic fatigue test can be considered as a valid measure of anaerobic work capacity (as determined by total work performance during a 30-s Wingate anaerobic test).
- The 95% limits of agreement are two large to allow a direct comparison between both measures. In other words, it is not possible to estimate the magnitude of performance improvement during a 30-s Wingate anaerobic test from that observed during a high intensity isokinetic fatigue test.
- In addition to provide sport scientists and coaches with measures of peak torque and ratios between agonists and antagonists muscles in a perspective of injury prevention, isokinetic dynamometry can also be used in the physiological assessment of athletes. However, some precautions should be taken in the interpretation of data.

✉ **Laurent Bosquet**
Laboratory MOVE (EA6314), University of Poitiers, 8, allée Jean Monnet, TSA 31113, 86073 Poitiers cedex 9, France