COMPARISON OF MEN'S AND WOMEN'S 100 M FREESTYLE PERFORMANCES AT THE 1996 PARALYMPIC GAMES

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Swimming competition for persons with a loco-motor disability is organised according to a functional classification system. One manner of checking the validity of this system is to compare the race results of men and women, in this case for the 100 m freestyle at the 1996 Paralympic Games. Men swam faster than women and had longer stroke lengths but no differences in stroke rate. Starting and turning ability did not differ. Women finished faster. In general the pattern of differences between Olympic and Paralympic swimmers and among classes was similar in men and women, supporting the validity of the functional classification system used for freestyle.

KEY WORDS: disability swimming, paralympics, freestyle

INTRODUCTION: Swimming competition for persons with a loco-motor disability is organised according to a functional classification system. Swimmers are placed into one of 10 classes according to scores on muscle testing, range of motion tests, co-ordination and/or level of amputation. One combination of tests is used to make classification for the freestyle, backstroke and butterfly events (the S classes) and another combination is used for breaststroke (the SB classes). In freestyle class S10 is the most functional.

In this functional system, swimmers with varying impairments compete together in any one class. The distribution of impairments over classes is not fixed. Furthermore, due to considerations of medical ethics, individual impairment profiles of the swimmers in each class are not made public. Thus, any clarification of differences in End Race Results (ERR) among classes remains speculative. This becomes even more evident when such race segment times as starting, turning and finishing are compared. Some swimmers in the same class may, for example, be able to push off the wall and take a diving start while others may have to start in the water but swim faster between the walls.

One possible way to avoid these pitfalls is to perform follow-up studies of the performances at major international championships over several years. The functional classification system is, however, still in evolution. It has in fact been adjusted following each of the last two Paralympic games. Most recently the number of functional classes in breaststroke has even been reduced from 10 to 9.

An alternative means of monitoring the validity of classification is to examine men's and women's results. Therefore, the purpose of this study was to compare the performances of men and women in the 100 m freestyle at the 1996 Paralympic Games. This event is of primary interest for a number of reasons. The 100 m freestyle is the only event in which all functional classes compete at Paralympic level. It is also the most popular. At least 30% more swimmers compete in freestyle than in the other strokes at the same distance. In men Paralympic swimmers, the 100 m freestyle has been found to have a depth of field comparable to the Olympic event (Daly, Malone, Vanlandewijck, & Steadward, 1999).

METHOD: With the approval of the International Paralympic Committee Sports Assembly Executive Committee for Swimming, the 100 m freestyle preliminary heats were video recorded for all men (N=171) and women (N=123) at the 1996 Paralympics. The same was done for the 1996 Olympic finalists and consolation finalists (N=16 men & 16 women), (IOC, 1996). Static surveillance cameras were placed perpendicular to the swimming direction at 7.5 m, 10 m, 15 m, 25 m and 42.5 m from the start. Camera data (30F/s) was fed to a video recorder via a central control panel and embedded with the time code from the official timing system. From these recordings performance variables were measured: clean swimming speed (CSS) per 25 m race segment, start time (ST = first 10 m for Paralympic and 15 m for Olympic swimmers), finish times (FT = final 7.5 m), and turn time (TT = 7.5 m in + 7.5 m out). In addition, stroke rate (SR = time for two strokes) and stroke length (SL) were measured during each race lap. When arm movements could not be seen from above water, bobbing actions and/or breathing frequency was used to estimate SR.

To compare the performances between men and women and among functional classes, individual swimming times were converted to a point score using the function:

$$Pts_{(individual)} = C_{(group)} * 100 \text{ m } TIME^{(-3)}$$

C is a constant based on the world record for the specific group (class and gender) (Van Tilborgh, Daly, Vervaecke & Persyn, 1984). The $C_{(group)}$ is calculated by assigning the group World Record 1000 pts. The group mean point score reflects the relative level of difficulty or competitiveness of that group.

To obtain a more normal distribution of performances, necessary for some statistical applications, the swimming times were also converted to a second point score called the class 10 point. Here the $C_{(group)}$ for class S10 was used to calculate a performance point score for all swimmers within each gender group. Olympic performances faster than the class S10 World Record received, in fact, more than 1000 pts for this application.

ST, TT and FT were converted to speed (m/s). In women this accounted for the difference in distances used for ST between Olympic (15 m) and Paralympic (10 m) events. To better compare race segment times between classes and gender groups, indexes were also calculated. These related the point score for a race segment to CSS. ST, TT and FT were, therefore, also assigned a point score by extrapolating the race segment time to a time for an entire 100 m distance. This time was used in the formula above to obtain a point score based on $C_{(s10)}$. By dividing the race segment point by the CSS point it could be determined if the swimmers started, turned or finished faster or slower than they actually swam.

A relative SL or SR score was determined by calculating the regression line between SL or SR and race mean CSS for all swimmers, both men and women. The individual residual value relative to the regression line was then taken as relative score. For further statistical analyses, two-way ANOVA for the effects of gender and class was made using the SAS statistical package for PC (version 6.12). When possible some comparison of group means was done using Duncan's multiple range test.

Table **1** Number of **100** m Freestyle Participants in the Paralympic Functional Classes

	S10	S9	S8	S7	S6	S5	S4	S3	S2
Men	24	21	25	26	18	13	14	11	6
Women	11	22	10	16	18	8	8	8	6

RESULTS: The numbers of participants in the 100 m freestyle in each functional class for both men and women at the Atlanta Paralympic games is given in Table 1. There are approximately 33% more participants in men than in women. The results from the two-way ANOVA on selected race variables for gender and class are given in Table 2. The men are significantly faster than women in ERR as well as CSS. Classes S5 and S4 are however, not significantly different. The mean performances of men and women in classes S5 only differ by 2%. Although there is a significant class effect, and in both men and women the performances decrease systematically with class, all classes are not always significantly faster than the next lower functional class. The pattern of differences among classes is, however, generally the same in men and women for both ERR and CSS. There is a class effect but no gender effect for competitiveness. The Olympic event shows the most depth, although there are few significant differences between groups and competitiveness does not systematically decrease with class.

Table 2 F-values for Two-way **ANOVA** by Gender and Class

	F-values		
Race variables	Gender	Class	Gender X Class
End Race Result (ERR)	8.48**	826.00***	2.77*
Clean Swimming Speed (CSS)	233.37***	516.33***	1.97*
Class Point (Competitiveness)	3.07	323***	5.00***
Stroke Length (SL)	61.53***	82.02***	1.90
Relative Stroke Length	5.53*	3.98***	2.39**
Stroke Rate (SR)	0.84	9.13***	1.97*
Relative Stroke Rate	3.39	3.34***	2.17*
Starting Speed	170.27***	324.86***	6.81***
Starting Index	3.59	8.97***	4.74***
Turning Speed	214.28***	509.15***	4.28***
Turning Index	0.20	6.50***	1.09
Finishing Speed	120.22***	323.97***	3.28**
Finishing Index	4.52*	2.40**	1.32

Significance • $p<.05$, ** $p<.01$, *** $p<.001$

There is a significant gender effect for SL and relative SL but not for SR or relative SR. Men have longer SL. There is a significant class effect for all these variables. SL decreases from Olympic to Paralympic swimmers and with functional class in both men and women. SR decreases but not systematically with functional class.

There is a gender and class effect as well as interaction for the starting, turning and finishing speed. Men were always faster. Differences per group between men and women for the starting, turning and finishing speed reflected those of the ERR and CSS. There were no differences in class S5. There was no gender effect for start or turning indexes. Women finished faster in relation to their CSS than men did. There is a class effect for these last two variables and interaction between gender and class for the start index. The actual differences between groups are few, however, and there is no relation with functional class.

DISCUSSION: Although more men participated in the Paralympic 100 m freestyle than women there was no significant effect for gender on competitiveness. In general, this supports the legitimacy of comparing these groups for other performance variables. The differences found will be real and not due to a difference in relative athletic ability. Nevertheless, the situation may not be so simply described as might seem. The competitiveness of men in classes S9 and S8 was quite a bit higher than in women. There was also a class effect on competitiveness and interaction between gender and class.

Although mean competitiveness did not decrease with class, there is a second measure, which has not been mentioned. The point score of the 8th place finisher also gives an idea of depth of field. In men, the score of the 8th place finisher is around 850 pts for classes S7 and above. In women's classes S10, S7 and S6, the 8th place finisher obtained more than 700 pts, while class S9 had 861 pts but the under-populated class S8 lagged behind with 582 pts. The 8th place score in the lower classes decreased seriously.

There is actually no difference in the competitiveness of Olympic men (M = 911 pts, SD = 31) and women (M = 909 pts, SD = 30). This supports the validity of the system for comparing competitiveness between men and women and among functional classes.

As expected the men swim faster than women do. There is no significant difference, however, in two of the lower classes (S5 & S4). These men and women also did not differ significantly in competitiveness. Nevertheless, these classes were the least competitive, especially in women. Perhaps as competitive level decreases, the natural differences between the men and women become more vague.

The results also support the idea that increased swimming speed is the result of increased SL rather than SR (Arellano, Brown, Cappaert & Nelson, 1994). Men had longer SL than women and SL decreased with functional class. Malone, Daly, Vanlandewijck and Steadward, (1998) found in men's 400 m freestyle that although the race mean SL decreased with ERR, within a race, an individual's own swimming speed changed due to changing SR rather than SL. A study of the two race lengths in the 100 m event is needed.

There was no gender effect for starting or turning indexes. Olympic swimmers did start relatively faster than Paralympic swimmers in both men and women. Olympic men also started significantly faster than Olympic women did. However, this distinction in explosive push-off ability was not as prominent in turning. Olympic swimmers turn relatively faster than Paralympic swimmers but the men are not better than women are. Paralympic swimmers finished relatively faster than Olympic swimmers. Paralympic swimmers increase their swimming speed in the last 7.5 m of the race more then Olympic swimmers do. The use of the point score to calculate this index took into account the fact that more energy is required to increase speed at the finish when race mean CSS is high than when it is low.

CONCLUSION: This study shows that despite decreased function the manner in which both men and women Paralympic swimmer achieve swimming speed and start, turn and finish is not drastically different from that of Olympic swimmers. The implication is that many Paralympic swimmers can be integrated in able-bodied clubs and even participate in able-bodied races. This can only lead to further improvement of Paralympic swimming.

REFERENCES:

Arellano, R., Brown, P., Cappaert J., & Nelson, R.C. (1994). Analysis of 50-, 100-, and 200-m Freestyle Swimmers at the 1992 Olympic Games. *Journal of Applied Biomechanics,* **19,** 189-200.

Daly, D.J., Malone, L.A., Vanlandewijck, Y., & Steadward, R.D. (1999). Analysis of the Men's 100 m Freestyle at the 1996 Atlanta Paralympic Games. In K.L. Keskinen, P.V. Komi & A.P. Hollander (Eds.), *Proceedings of the V111 International Symposium on Biomechanics and Medicine in Swimming,* Jyvaskyla, Finland.

IOC Subcommission on Biomechanics and Physiology of Sport (1996). Competition Analyses of Swimming Events: Olympics Games, Men's Events (available from D.J. Smith, Faculty of Kinesiology, University of Calgary, Canada)

Malone, L.A., Daly, D.J., Vanlandewick, Y., & Steadward, R.D. (1998). Race analysis of the 400 m freestyle at the 1996 Paralympic games. In H.J. Riehle & M.M. Vieten (Eds.) *Proceedings I: XVII International Symposium on Biomechanics in Sport,* Konstanz, Germany: Universitatsverslag Konstanz GmbH.

Van Tilborgh, J., Daly, D., Vervaecke, H., & Persyn, U. (1984), The evolution of some crawl performance determinant factors in women competitive swimmers. In J. Borms, R. Hauspie, A. Sand, C. Suzzanne,& M. Hebbelinck (Eds.). *Human Growth and Development* (pp. 666-676). New York: Plenum Press.

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