Anthropometric characteristics of elite male junior rowers

Jan Bourgois, Albrecht L Claessens, Jacques Vrijens, Renaat Philippaerts, Bart Van Renterghem, Martine Thomis, Melissa Janssens, Ruth Loos, Johan Lefevre

Abstract
During the 1997 Fédération Internationale des Sociétés d’Aviron World Junior Rowing Championships, anthropometric data on 383 male junior rowers were assessed. With 430 participating athletes, the sample represented 89% of the population. In addition to age, 27 dimensions were measured: body mass, six heights or lengths, four breadths, 10 girths, and six skinfolds. The elite male junior rowers were tall (187.4 (5.8) cm; mean (SD)) and heavy (82.2 (7.4) kg), with larger length, breadth, and girth dimensions than a nationally representative sample of Belgian boys of the same chronological age. A rowing specific anthropometric profile chart with norms was constructed. The stature of the junior rowers is similar to that of adult heavyweight elite rowers, except that the junior rowers are lighter. Compared with non-finalists, finalists are heavier (but still lighter than the adult heavyweight elite rower) and taller, with greater length, breadth (except for the bicristal diameter), and girth dimensions. (Br J Sports Med 2000;34:213–217)

Keywords: anthropometry; body size; males; junior; rowers

Elite athletes of different sports differ in physical and physiological characteristics. We expected the elite athlete to represent an expression of heredity, physical training, nutrition, and sociocultural factors. Description and analysis of top level athletes include kinaanthropometry, which is the study of human size, shape, proportion, composition, and gross motor function in order to understand growth, exercise performance, and maturation. The chosen variables can be restricted to anthropometric dimensions. The quantification of physique, which can be called anthropometry, of top level athletes is a reference in relating sports performance and body structure.

Rowing has been extensively studied. Anthropometric data for adult male and female rowers emphasise the importance of body mass and body size for rowing performance. The profile of male junior rowers may be used in evaluating models for talent identification. To establish a “sport specific” anthropometric profile, a certain number of elite athletes from the same sport or event, measured for several anthropometric dimensions in standardised circumstances, are necessary. The 1997 World Junior Rowing Championships provided the opportunity to carry out a comprehensive anthropometric investigation. The aims of this study were to: (a) describe the body size of male junior rowers; (b) compare the anthropometric data of finalists (those rowers who were ranked in the top six) and non-finalists; (c) establish a rowing specific anthropometric profile chart for male juniors to be used for rowing training and performance.

Methods

SAMPLE
Forty three countries participated in the male events of the 1997 World Junior Rowing Championships, and participants from 41 countries were measured. Anthropometric data were collected on 383 junior male rowers, who included competitors and reserves (4.4% of the total sample). Coxwains were not measured. With 430 participating male athletes, the sample represented 89% of the population. Most of the rowers were from Europe (83.8%) and most were white (91.6%). For all rowing events, 80–100% of the competitors were measured, including 83% of the winners and medalists as well as 89% of the finalists. The age of the junior rowers varied between 15.1 and 18.6 years with a mean of 17.8 (0.7) years. They trained 7 to 10 times (10–15 hours) a week.

DATA COLLECTION
The protocols and techniques for this project were approved by the board of the Fédération Internationale des Sociétés d’Aviron. When the rowers arrived, they completed a form requesting certain personal and training data. Techniques were based on the procedures given by Claessens et al. For some measurements, the procedures outlined by Lohman et al, Norton et al, and Ross and Marfell-Jones were followed. The selected anthropometric dimensions were based on (a) the factor analytical classification of physique to characterise the
DATA ANALYSIS

Variables were tested for their skewness. Except for the biceps skinfold, the suprailiac skinfold, and the calf skinfold, all other variables fitted to a normal distribution. Mean, standard deviation, and minimum and maximum values are presented.

As most of the subjects were European and white, normative reference data (for the age closest to the mean chronological age of the male junior rowers) of Belgian secondary schoolboys aged 17.5–18 years were used for comparison. A profile chart with norms, using percentiles (P values of 5, 10, 25, 50, 75, 90, 95), was constructed. To compare the anthropometric data of finalists and non-finalists, an independent two sample t test analysis was carried out. The 1% level was chosen to represent statistical significance. The statistical analysis system programme was used.

Table 3 Anthropometric profile chart for male junior rowers (n=383)

<table>
<thead>
<tr>
<th>Percentiles</th>
<th>5</th>
<th>10</th>
<th>25</th>
<th>50</th>
<th>75</th>
<th>90</th>
<th>95</th>
</tr>
</thead>
<tbody>
<tr>
<td>Body mass (kg)</td>
<td>59.8</td>
<td>73.0</td>
<td>77.2</td>
<td>81.9</td>
<td>87.0</td>
<td>92.3</td>
<td>94.7</td>
</tr>
<tr>
<td>Stature (cm)</td>
<td>171.3</td>
<td>179.2</td>
<td>183.6</td>
<td>187.6</td>
<td>191.4</td>
<td>195.2</td>
<td>196.6</td>
</tr>
<tr>
<td>Sitting height (cm)</td>
<td>91.5</td>
<td>92.7</td>
<td>94.5</td>
<td>96.7</td>
<td>98.9</td>
<td>100.8</td>
<td>102.3</td>
</tr>
<tr>
<td>Leg length (cm)</td>
<td>84.4</td>
<td>85.3</td>
<td>88.1</td>
<td>90.8</td>
<td>93.3</td>
<td>95.9</td>
<td>97.3</td>
</tr>
<tr>
<td>Arm length (cm)</td>
<td>77.7</td>
<td>78.5</td>
<td>80.8</td>
<td>83.0</td>
<td>85.2</td>
<td>87.0</td>
<td>88.8</td>
</tr>
<tr>
<td>Biacromial diameter (cm)</td>
<td>38.6</td>
<td>39.4</td>
<td>40.4</td>
<td>41.5</td>
<td>42.5</td>
<td>43.5</td>
<td>44.2</td>
</tr>
<tr>
<td>Biacromial diameter (cm)</td>
<td>27.9</td>
<td>28.4</td>
<td>29.3</td>
<td>30.2</td>
<td>31.1</td>
<td>32.2</td>
<td>33.0</td>
</tr>
<tr>
<td>Humerus width (cm)</td>
<td>7.1</td>
<td>7.2</td>
<td>7.4</td>
<td>7.6</td>
<td>7.8</td>
<td>8.0</td>
<td>8.2</td>
</tr>
<tr>
<td>Femur width (cm)</td>
<td>9.6</td>
<td>9.8</td>
<td>10.0</td>
<td>10.3</td>
<td>10.6</td>
<td>11.0</td>
<td>11.1</td>
</tr>
<tr>
<td>Biceps girth (cm)</td>
<td>29.7</td>
<td>30.5</td>
<td>31.6</td>
<td>33.1</td>
<td>34.3</td>
<td>35.3</td>
<td>35.8</td>
</tr>
<tr>
<td>Forearm girth (cm)</td>
<td>26.6</td>
<td>27.3</td>
<td>28.5</td>
<td>30.0</td>
<td>31.2</td>
<td>32.1</td>
<td>33.2</td>
</tr>
<tr>
<td>Thigh girth (cm)</td>
<td>52.7</td>
<td>53.8</td>
<td>55.5</td>
<td>58.0</td>
<td>60.2</td>
<td>62.0</td>
<td>63.4</td>
</tr>
<tr>
<td>Calf girth (cm)</td>
<td>34.4</td>
<td>35.1</td>
<td>36.6</td>
<td>37.8</td>
<td>39.0</td>
<td>40.0</td>
<td>40.7</td>
</tr>
<tr>
<td>Biceps skinfold (mm)</td>
<td>5.0</td>
<td>5.3</td>
<td>5.6</td>
<td>5.9</td>
<td>6.1</td>
<td>6.4</td>
<td>6.7</td>
</tr>
<tr>
<td>Triceps skinfold (mm)</td>
<td>6.5</td>
<td>7.1</td>
<td>8.7</td>
<td>10.9</td>
<td>13.6</td>
<td>16.4</td>
<td>18.0</td>
</tr>
<tr>
<td>Calf skinfold (mm)</td>
<td>4.8</td>
<td>5.3</td>
<td>6.3</td>
<td>7.8</td>
<td>9.9</td>
<td>12.5</td>
<td>14.2</td>
</tr>
</tbody>
</table>

Table 3 gives an anthropometric profile chart. The scores for 20 anthropometric dimensions are located on the chart together with the corresponding percentile values—for example, P5, P10, P25, P50, P75, P90, and P95.
Table 4 Comparison of mean age, stature, and weight of male junior and elite heavyweight and lightweight rowers competing in international tournaments

<table>
<thead>
<tr>
<th>Category</th>
<th>n</th>
<th>Age (y)</th>
<th>Stature (cm)</th>
<th>Body mass (kg)</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Juniors</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| German national team 1975       | 27 | 18.0    | 186.6        | 81.6           | Ditter and Nowacki
| British and Greek national team | 8  | 17.6    | 190.2        | 83.1           | Routtedakis and Sharp
| Belgian national team 1988      | 10 | 17.0    | 186.8        | 81.2           | J Bourgois and J Vrijens
| German national team 1989       | 19 | 17.5    | 191.5        | 83.7           | Steinmacher et al
| World Championships 1997        | 383| 17.8    | 187.4        | 82.2           | Present study |
| Elite heavyweight                |    |         |              |                |           |
| Olympic Games 1968              | 85 | 24.3    | 185.1        | 82.6           | De Garay et al
| Olympic Games 1976              | 68 | 24.2    | 191.3        | 90.0           | Carter et al
| FISA champions                  | 14 | 25.6    | 192.0        | 93.0           | Secher
| FISA competitors                | 13 | 25.1    | 189.0        | 84.0           | Secher
| Dutch national team 1988        | 18 | 24.1    | 190.0        | 79.3           | Rieus et al
| Elite lightweight               | 144| 24.3    | 180.7        | 70.3           | Rodriguez |

Discussion

Rowing is a strength endurance type of sport, and body size and mass are undoubtedly performance related factors. An anthropometric profile of young rowers was carried out using a standard test battery, which includes body mass, stature, length, and breadth variables for the estimation of skeletal robustness, arm and leg girths for the evaluation of muscle development, and skinfold thicknesses for the estimation of fat mass and fat-free mass. The individual data were compared with a reference group. A further step is the construction of a profile chart with norms. The American College of Sports Medicine argues that youngsters should, if possible, be counselled towards sports that are realistic given the individual body type.

The male junior rowers were 7% taller and 27% heavier than the reference group. On the basis of the descriptive data for 14 male adult champions, Shephard concluded that outstanding rowers are 10% taller and 27% heavier than the general Canadian population. Malina suggested that there is no effect of regular training for rowing on statural growth and noted that rowers are already taller than average during childhood, maintaining their position relative to reference data during childhood and adolescence.

Table 4 gives a comparison of the mean age, stature, and body mass of male junior and elite heavyweight and lightweight rowers (table 4). Considerably thinner skinfolds were found in elite lightweight rowers. Long legs increase the drive phase of the rowing stroke.

As compared with Olympic heavyweight rowers, junior rowers have somewhat higher values for the subscapular, thigh, and calf skinfolds, but a lower value for the triceps skinfold (table 5). Considerably thinner skinfolds were found in elite lightweight rowers.

To evaluate the physical characteristics of junior rowers, an anthropometric profile chart was constructed (table 3). This profile gives an overall evaluation of the body characteristics of a subject in relation to his group. The chart can

Junior rowers have greater length dimensions and greater breadths and girths than the reference group and lightweight rowers but lower values (except for the bicristal diameter) than heavyweight rowers (table 5). Sklad et al found that a year of training increased arm and chest circumferences, and relative body mass in 41 male junior rowers aged 17–18 years.

The most able young rowers could be distinguished by their stature, skeletal robustness, and muscular development. This is supported when comparing the anthropometric characteristics of finalists and non-finalists. Finalists were heavier and taller, with higher values for length, breadth (except for the bicristal diameter), and girth dimensions (table 2). Data for adult heavy weight rowers indicate that winners are consistently heavier and taller than the average for competitors participating in World Championships and Olympic Games. Rodriguez found that lightweight medallists are lighter (~0.6 kg) than non-medallists, with higher values for length, breadth, and girth dimensions.

Calculated from the mean values in the different studies, junior rowers seem to have a lower sitting height relative to stature (51.6%) and a higher leg length relative to stature (48.4%) compared with the normative reference group (52.1% and 47.9% respectively) and the heavyweight Olympic rowers (52.1% and 47.9% respectively). No differences were found between junior rowers and elite lightweight rowers. Long legs increase the drive phase of the rowing stroke.

As compared with Olympic heavyweight rowers, junior rowers have somewhat higher values for the subscapular, thigh, and calf skinfolds, but a lower value for the triceps skinfold (table 5). Considerably thinner skinfolds were found in elite lightweight rowers.

To evaluate the physical characteristics of junior rowers, an anthropometric profile chart was constructed (table 3). This profile gives an overall evaluation of the body characteristics of a subject in relation to his group. The chart can

Table 5 Comparison of mean length, breadth, girth, and skinfold measurements of male junior rowers (present study), elite heavyweight and lightweight rowers competing in international tournaments

<table>
<thead>
<tr>
<th>Body dimensions</th>
<th>Elite heavyweight (n=65)</th>
<th>Elite lightweight (n=144)</th>
<th>Male junior rowers (n=283)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sitting height (cm)</td>
<td>99.7</td>
<td>93.8</td>
<td>96.8</td>
</tr>
<tr>
<td>Tibial height (cm)</td>
<td>53.4</td>
<td>50.4</td>
<td></td>
</tr>
<tr>
<td>Leg length (cm)</td>
<td>91.7</td>
<td>87.6</td>
<td>90.7</td>
</tr>
<tr>
<td>SHSR (%)</td>
<td>52.1</td>
<td>51.5</td>
<td>51.6</td>
</tr>
<tr>
<td>LLSR (%)</td>
<td>47.9</td>
<td>48.5</td>
<td>48.4</td>
</tr>
<tr>
<td>Biacromial diameter (cm)</td>
<td>42.5</td>
<td>36.0</td>
<td>41.5</td>
</tr>
<tr>
<td>Bicristal diameter (cm)</td>
<td>30.2</td>
<td>28.5</td>
<td>30.3</td>
</tr>
<tr>
<td>Humerus width (cm)</td>
<td>7.8</td>
<td>7.6</td>
<td></td>
</tr>
<tr>
<td>Femur width (cm)</td>
<td>10.4</td>
<td>10.3</td>
<td></td>
</tr>
<tr>
<td>Biceps girth (cm)</td>
<td></td>
<td>30.7</td>
<td>32.9</td>
</tr>
<tr>
<td>Forearm girth (cm)</td>
<td>30.3</td>
<td>25.6</td>
<td>28.6</td>
</tr>
<tr>
<td>Thigh girth (cm)</td>
<td>60.3</td>
<td>51.0</td>
<td>57.9</td>
</tr>
<tr>
<td>Calf girth (cm)</td>
<td>39.3</td>
<td>34.4</td>
<td>37.7</td>
</tr>
<tr>
<td>Triceps skinfold (mm)</td>
<td>8.4</td>
<td>5.5</td>
<td>7.9</td>
</tr>
<tr>
<td>Subscapular skinfold (mm)</td>
<td>8.7</td>
<td>8.0</td>
<td>8.9</td>
</tr>
<tr>
<td>Thigh skinfold (mm)</td>
<td>10.8</td>
<td>8.0</td>
<td>11.5</td>
</tr>
<tr>
<td>Calf skinfold (mm)</td>
<td>6.3</td>
<td>5.4</td>
<td>8.4</td>
</tr>
</tbody>
</table>

SHSR, sitting height to stature ratio; LLSR, leg length to stature ratio.
be used as a screening device and the interpretation of any profile should therefore be seen in its specific individual context.

In conclusion, elite junior rowers are tall and heavy, with greater length, breadth, and girth dimensions than a reference group of the same chronological age. Within the group of elite male junior rowers, significant differences exist between finalists and non-finalists in length, breadth, and girth dimensions and for body mass. The anthropometric profile chart is a useful instrument for coaching and advising. It allows sport scientists and coaches to construct anthropometric profiles easily for individual rowers against templates.

The authors wish to express their appreciation to all members of the Organising Committee of the 1997 World Junior Rowing Championships, Hazewinkel-Willebroek, and to the Fédération Internationale des Sociétés d’Aviron for their permission to set up this study and for their full support and collaboration during the investigations. Many thanks to Marianne Moroos and to the following students for their assistance: Dimitri Durney, Bert Sep, Elke Sep, and Karl Stock. Also many thanks are given to the athletes, coaches, medical staff members, and delegation chiefs for their benevolence in giving permission to measure the rowers under their authorisation. Saucere also thanks also to M De Brie and P Coorevits, who typed this manuscript.

Contributors: J B, A L C, and J V were responsible for all the statistical and administrative functions of this study. J B made the initial proposal to the Fédération Internationale des Sociétés d’Aviron, initiated and coordinated the study, participated in the protocol design, data collection, and analysis, and wrote and edited the paper. A L C coordinated the study, designed the protocol, was appointed the criterion anthropometrist for this study, participated in the execution of the study, particularly data collection, data documentation, quality control, and analysis of data, and participated in writing and editing the paper. J V initiated and coordinated the study, discussed ideas, and participated in the protocol design, analysis of data, writing and editing the paper. R P, B Van R, M T, M J, and R L participated in the protocol design, discussed ideas, participated in data collection, particularly measuring and data analysis, and contributed to the paper. J L participated in the protocol design, discussed ideas, performed and interpreted statistical analysis, and contributed to the paper.


Take home message
The study of the body size of elite male junior rowers is very useful in view of the rapid evolution of sports and sportspersons, and against the background of secular trends in body size of the general population. This study will provide a better understanding of the relationships between physical structure and performance in young rowers. The anthropometric profile chart is a useful instrument for coaching and advising.

Commentary
When researching athletic populations, it is seldom practical or possible to collect extensive data on well trained subjects. This is primarily due to limited access to such subjects and also because of the finite nature of the population. In this context, the current study provides a unique and extensive profile of the anthropometric characteristics of well trained Junior male rowers, who comprised 89% of rowers competing in the 1997 World Championships.
The data collected when compared with age matched reference data revealed a number of differences in the variables measured. Further analysis should focus on the identification of which anthropometric characteristics, if any, differentiated medal winners at the Junior World Championships and their less successful counterparts. By developing such a profile, in addition to the anthropometric profile chart presented in the study, it may be possible to discern which anthropometric characteristics, if any, are important to rowing performance in Junior rowers and therefore worth measuring from a sports specific perspective. This may have profiling implications in terms of talent identification and development of young rowers as previous research in this area has almost exclusively focused on adult rowers.

GILES D WARRINGTON
University of Limerick, Ireland

Sporting miscellany

Jerry Morris: pathfinder for health through an active and fit way of life

We extend greetings and best wishes to Jeremy Noah Morris on the occasion of his 90th birthday celebration, 6 May 2000. Professor Morris, better known as Jerry, was born in Liverpool, educated in Glasgow and London, and today is Emeritus Professor of Public Health at the London School of Hygiene and Tropical Medicine. He is a renowned physician-epidemiologist who has made landmark scientific contributions to our understanding of physical exercise and dietary intake as they affect risk of developing coronary heart disease (CHD, or heart attack), and to our understanding of the role of social inequalities in risk of disease. As a protagonist, he has worked tirelessly to develop public policies to prevent disease, promote good health, and overcome those social factors that predispose to disease and limit access to health care. Based on three long term studies over the last half century, one of London transport workers and two of executive grade British civil servants, Jerry Morris has demonstrated conclusively that a physically active and physiologically fit lifestyle lowers risk of heart attack and prolongs high quality living. On the basis of his observations on occupational work and leisure time recreation, Professor Morris is generally considered a guiding spirit to good health through modern day sports medicine and exercise science. Here I summarise briefly some of the pertinent findings from three of his seminal studies.

The first study by Morris and his colleagues was of transport workers, which showed that highly active conductors in double decker buses were at lower risk of CHD than drivers who sat through their shifts at steering wheels. If conductors did develop the disease, it was less severe and occurred at later ages. Morris et al also found that postmen delivering the mail on foot had similarly lower CHD rates than sedentary postal clerks and telephonists. Analysing national death rates in an early test of their hypothesis, the Morris team found gradient levels of CHD with occupations of intermediate physical activity.

Realising that the connection between sedentary living and heart attack risk could be a two way street—that is, sedentary habits could be both a cause and an effect of heart attack—Morris and his associates effectively attacked potential selective and confounding characteristics. In a wide range of observations, they found confirmatory differences at autopsy in the hearts of men corresponding to the physical activity entailed in their jobs. Also, blood pressure levels were lower in the conductors, and at the same levels of blood pressure they suffered fewer heart attacks than the drivers. Bus drivers were indeed more obese, but their rate of sudden heart attack death was higher, whatever their physique.

In a second pioneering study, Morris and associates chose middle aged civil servants free of clinical CHD who held sedentary desk jobs and traced them over time for CHD occurrence and death. Contrary to expectation, no benefit in lower heart attack incidence was found from high totals of leisure time physical activity. Instead, men engaging in vigorous exercise (defined as liable to reach peaks of 7.5 kcal per minute—for example, running at about 6 mph) did manifest less than half the disease of their fellow workers, who were comparable in health status and health habits. Morris et al also found that the rise with age in both fatal and non-fatal first heart attacks was appreciably less in the men reporting such apparently beneficial vigorous exercise. The benefit was as evident at the end of the follow up period as at the beginning. Eliminating the effect of other causes (smoking, high blood pressure, obesity) of heart disease did not change the main finding, namely protection against heart attack by moderately vigorous or vigorous activity.

In a third major study, again in civil servants, Morris et al showed that only the vigorous aerobic exercise (swimming, brisk walking, cycling, and intense group play as in soccer) was accompanied by lower heart attack incidence; no benefit was evidenced from miscellaneous recreational work, such as gardening and do it yourself activities. And again, totals of physical activity, including general “puttering about”, were unrelated to heart attack incidence. They also showed that incidence rates were low only among men who actively participated in contemporary (proximate) vigorous sports.

The scientific contributions of Jerry Morris have helped establish the concept that patterns of sports play, food consumption, tobacco smoking, and other lifestyle elements alter the hazards of heart disease and premature death. Favourable adjustments of such patterns promote improved health and lengthen high quality life. Heading into his ninety first year, Professor Morris continues to work on identifying the relative importance of intensity, frequency, and duration of recreational activities to promote good health. He envisages designing exercise prescriptions and intervention techniques that will prove useful to policy makers in promoting sports play for all. We wish him all the best, with continued opportunity for his own weekly exercise protocol: three days in the pool and three at the gym, 30 minutes on each occasion.

RALPH S PAFFENBARGER, JR
Emeritus (Active) Professor of Epidemiology
Stanford University School of Medicine
Jerry Morris: pathfinder for health through an active and fit way of life

Ralph S Paffenbarger, Jr

doi: 10.1136/bjsm.34.3.217

Updated information and services can be found at:
http://bjsm.bmj.com/content/34/3/217

These include:

Email alerting service
Receive free email alerts when new articles cite this article. Sign up in the box at the top right corner of the online article.

Notes

To request permissions go to:
http://group.bmj.com/group/rights-licensing/permissions

To order reprints go to:
http://journals.bmj.com/cgi/reprintform

To subscribe to BMJ go to:
http://group.bmj.com/subscribe/