Right Ventricle Best Predicts the Race Performance in Amateur Ironman Athletes

ALAIN MARCEL BERNHEIM[1], CHRISTINE HELENA ATTENHOFER JOST[2], MICHEL ZUBER[3], MONICA PFYFFER[2], BURKHARDT SEIFERT[4], GABRIELLA DE PASQUALE[1], ANDRE LINKA[5], ANJA FAEH-GUNZ[2], ARGELIA MEDEIROS-DOMINGO[2], and BEAT KNECHTLE[6,7]

[1]Department of Cardiology, Stadtspital Triemli, Zurich, SWITZERLAND; [2]Cardiovascular Center Zurich, Klinik Im Park, Zurich, SWITZERLAND; [3]Department of Cardiology, Kantonsspital Lucerne, Lucerne, SWITZERLAND; [4]Division of Biostatistics, ISPM, University of Zurich, Zurich, SWITZERLAND; [5]Department of Cardiology, Kantonsspital Winterthur, Winterthur, SWITZERLAND; [6]Institute of General Practice and Health Services Research, University of Zurich, Zurich, SWITZERLAND; and [7]Gesundheitszentrum St. Gallen, St. Gallen, SWITZERLAND

ABSTRACT

BERNHEIM, A. M., C. H. ATTENHOFER JOST, M. ZUBER, M. PFYFFER, B. SEIFERT, G. DE PASQUALE, A. LINKA, A. FAEH-GUNZ, A. MEDEIROS-DOMINGO, and B. KNECHTLE. Right Ventricle Best Predicts the Race Performance in Amateur Ironman Athletes. *Med. Sci. Sports Exerc.*, Vol. 45, No. 8, pp. 1593–1599, 2013. **Purpose**: The ironman (IM) triathlon is a popular ultraendurance competition, consisting of 3.8 km of swimming, 180.2 km of cycling, and 42.2 km of running. The aim of this study was to investigate the predictors of IM race time, comparing echocardiographic findings, anthropometric measures, and training characteristics. **Methods**: Amateur IM athletes (ATHL) participating in the Zurich IM race in 2010 were included. Participants were examined the day before the race by a comprehensive echocardiographic examination. Moreover, anthropometric measurements were obtained the same day. During the 3 months before the race, each IM-ATHL maintained a detailed training diary. Recorded data were related to total IM race time. **Results**: Thirty-eight IM finishers (mean ± SD age = 38 ± 9 yr, 32 men [84%]) were evaluated. Total race time was 684 ± 89 min (mean ± SD). For right ventricular fractional area change (45% ± 7%, Spearman $\rho = -0.33$, $P = 0.05$), a weak correlation with race time was observed. Race performance exhibited stronger associations with percent body fat (15.2 ± 5.6%, $\rho = 0.56$, $P = 0.001$), speed in running training (11.7 ± 1.2 $km \cdot h^{-1}$, $\rho = -0.52$, $P = 0.002$), and left ventricular myocardial mass index (98 ± 24 $g \cdot m^{-2}$, $\rho = -0.42$, $P = 0.009$). The strongest association was found between race time and right ventricular end-diastolic area (22 ± 4 cm^2, $\rho = -0.64$, $P < 0.0001$). In multivariate analysis, right ventricular end-diastolic area ($\beta = -16.7$, 95% confidence interval = −27.3 to −6.1, $P = 0.003$) and percent body fat ($\beta = 6.8$, 95% confidence interval = 1.1–12.6, $P = 0.02$) were independently predictive of IM race time. **Conclusions**: In amateur IM-ATHL, RV end-diastolic area and percent body fat were independently related to race performance. RV end-diastolic area was the strongest predictor of race time. The role of the RV in endurance exercise may thus be more important than previously thought and needs to be further studied. **Key Words:** ULTRAENDURANCE TRAINING, RACE TIME, ECHOCARDIOGRAPHY, RIGHT VENTRICULAR SIZE

The ironman (IM) distance is the most popular among the long-distance triathlons. It consists of 3.8 km of swimming, 180.2 km of cycling, and 42.2 km of running (26). Participation in IM triathlon competitions requires intensive endurance training in these three sports disciplines. It is thus an example of an ultraendurance exercise combining both dynamic and static elements.

Intensive endurance training leads to physical adaption, resulting in changes in body composition. Anthropometric measurements are routinely used to assess body composition in endurance athletes (ATHL) (12,14,20,36). Anthropometry may vary between different groups of endurance ATHL, depending on training volume (15) and on the types of sportive disciplines performed (12,13).

The heart is also known to undergo an adaptive process in response to endurance exercise, including increased left ventricular (LV) chamber dimensions, wall thickness, and mass as well as atrial remodeling (2,3,33,34). Moreover, right ventricular (RV) remodeling with RV dilation and increased RV mass may occur (3,35). In IM-ATHL, enlargement of both ventricles and atria and increased LV muscle mass have been described (7).

There are limited data available on the correlation of anthropometric measurements and of training characteristics with IM race time. Some recent studies observed an association between lean body stature and race time in IM triathletes (14,16,17). Moreover, older investigations suggested that training volume may have an important influence on race

Address for correspondence: Alain Marcel Bernheim, M.D., Department of Cardiology, Stadtspital Triemli, Birmensdorferstrasse 497, 8063 Zurich, Switzerland; E-mail: Alain.Bernheim@triemli.stzh.ch.

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performance (11,31). More recent data, however, imply that intensity of training may be even more relevant for prediction of IM race time (17). For the correlation between cardiac adaptation to ultraendurance training and race performance, available information is sparse. Some data indicate that components of athlete's heart remodeling may be related to improved oxygen uptake (6,18,37). In runners, a correlation between LV chamber size and race time has been observed (23,24,29). In IM-ATHL, corresponding information on the influence of cardiac adaption on race time is lacking.

Whereas the LV has been the focus of many previous studies in athletes, the role of the RV in endurance sportive activities is less well defined. However, cardiac output is dependent not only on the left, but also on the right heart, because the LV can only eject what the right heart gives it. By functioning as a flow generator, the RV may thus importantly influence cardiac performance (27). In a previous study, the size of the RV was an independent predictor of maximal oxygen consumption (18). We hypothesized that the RV may also have an important effect on race performance in IM-ATHL.

The aim of the present study, therefore, was to investigate the predictors of race time, comparing parameters derived from a comprehensive echocardiographic examination of both the left and the right side of the heart, anthropometric measures, and a training diary in amateur IM triathletes.

METHODS

Study population. Amateur ATHL participating in the Ironman Switzerland race in Zurich on July 25, 2010, were included in this study. All IM-ATHL were contacted via a newsletter 3 months before the race and were asked to participate in this study. Upon inscription to the study, subjects were asked to keep a training diary. Study participants had no personal history of cardiovascular diseases and no family history of sudden cardiac death, inherited heart disease, or hypertrophic cardiomyopathy. Clinical measurements and a transthoracic echocardiogram were performed the day before the race. The study was approved by the local ethical committee. All subjects provided written informed consent.

Training diary. Study participants maintained a comprehensive training diary during the race preparation before the IM event. ATHL were asked to record their training units in all three disciplines showing distance, duration, and speed of each unit. From these data, the mean weekly hours, the mean weekly kilometers, and the mean speed per discipline were calculated.

Clinical and anthropometric measurements and calculations. The day before the race, blood pressure values and heart rate were collected. Capillary blood samples were drawn from the fingertip. Hematologic parameters were determined using ADVIA® 120 (Siemens Healthcare Diagnostics, Deerfield, IL). Body mass was measured using a commercial scale (Beurer BF 15; Beurer GmbH, Ulm, Germany) to the nearest 0.1 kg after voiding of the urinary bladder. Body height was determined using a stadiometer (Tanita HR 001 Portable Height Measure; Tanita Europe, Amsterdam, the Netherlands) to the nearest 1.0 cm. With these values, body mass index and body surface area were calculated (28). The circumferences and the lengths of the limbs were measured using a nonelastic tape measure (cm) (KaWe CE; Kirchner und Welhelm, Germany) to the nearest 0.1 cm. The circumference of the upper arm was measured at mid–upper arm; the circumference of the thigh was taken at midthigh, and the circumference of the calf was measured at midcalf. The skinfold data were obtained using a skinfold caliper (GPM-Hautfaltenmessgerät; Siber & Hegner, Zurich, Switzerland), and 10 skinfold data were recorded to the nearest 0.2 mm. The skinfold caliper measures with a pressure of 0.1 MPa ± 5% over the whole measuring range. The skinfold measurements were taken following the standard of the International Society for the Advancement of Kinanthropometry once for all four skinfolds, and then the procedure was repeated twice more by the same investigator; the mean of the three times was then used for the analyses. Skeletal muscle mass was calculated as previously described (22). Percent body fat was calculated using the anthropometric formula for men (4) and for women (5), according to Ball et al.

Echocardiography. The transthoracic echocardiographic examination was performed according to the guidelines of the American and European Society of Echocardiography using Vivid 9 ultrasound systems (GE Medical Systems, Milwaukee, WI) (21). For acquisition of two-dimensional (2-D) images, the transducer was first placed in a position to obtain the required echocardiographic view. In each position, the subject initially breathed normally. At a respiratory level where the acoustic window was found to be optimal, the subject was asked to hold breath until the image loops of three consecutive cycles were acquired. Doppler echocardiographic images were recorded with the subject breathing normally. For each Doppler interrogation, images of three consecutive beats were acquired. Derived parameters were averaged. Standard Doppler echocardiograms were recorded by three experienced echocardiographers (MZ, AL, and AF). Images for strain and strain rate analyses were recorded by two experienced operators (AB and CAJ). Echocardiographic data were stored digitally, and data analysis was performed off-line (EchoPac, version 7; GE Healthcare, Waukesha, WI).

LV ejection fraction and LV end-diastolic volumes were assessed using biplane Simpson's method. LV myocardial mass was calculated as recommended (21). RV end-diastolic area was chosen as measure of RV size (1,10). RV areas and RV fractional area change were calculated outlining the endocardial borders of the RV in end-diastole and in systole in the apical four-chamber view. Left atrial volume was calculated using the biplane area-length method. Right atrial volume was calculated using the single plane method of disks. LV diastolic function was assessed as previously described (30). Doppler echocardiographic parameters of the RV were measured in the apical four-chamber view. From pulsed wave Doppler interrogation of tricuspid inflow, RV-early (E) and

TABLE 1. Clinical characteristics and anthropometric variables of IM finishers and correlations with race time.

Parameter	Mean ± SD	Range	Correlation with Race Time	
			Spearman ρ	P
Age (yr)	38 ± 9	21–56	0.29	0.08
Systolic BP (mm Hg)	130 ± 10	110–149	−0.18	0.29
Diastolic BP (mm Hg)	72 ± 10	49–96	−0.03	0.85
Heart rate (bpm)	58 ± 11	40–98	0.08	0.65
Hematocrit (%)	43 ± 2	37–49	−0.31	0.08
Body weight (kg)	73 ± 10	54–92	−0.21	0.20
Body mass index ($kg{\cdot}m^{-2}$)	22.7 ± 1.7	18.3–26	−0.19	0.25
Body surface area (m^2)	1.9 ± 0.2	1.6–2.3	−0.24	0.15
Percent body fat (%)	15.2 ± 5.6	8.4–29.8	0.56	0.001
Skeletal muscle mass (kg)	39.2 ± 5.9	26.3–49	−0.27	0.13

BP, blood pressure.

RV-atrial (A) peak velocities were calculated. The tricuspid annular motion peak velocity in systole (RV s′) and the early diastolic annular velocity (e′) of the RV were measured using tissue Doppler imaging. Systolic RV to atrial pressure gradient was calculated from the gradient across the tricuspid valve, using the modified Bernoulli equation.

For strain analysis, the 2-D speckle tracking method was used (9,25). Gray-scale images were acquired with frame rates of 60–100 frames per second. The images were optimized for gain and sector width and standardized for sector depth and frequency. The LV global longitudinal strain was calculated from loops acquired from apical two-, three-, and four-chamber views. RV 2-D longitudinal strain was assessed in the modified apical four-chamber view. The RV was divided into six segments. Longitudinal strain for each segment and RV global longitudinal strain were calculated. For longitudinal strain analysis, a line of interest along the endocardial border and a second larger region near the epicardium were generated by the software to obtain a region of interest within the myocardial wall. The width of the region of interest could be adjusted for thicker and thinner walls. Automatic frame-by-frame tracking during the heart cycle yielded information on regional myocardial motion along the selected region of interest. The reliability of tracking was confirmed by the reliability parameters of the 2-D speckle tracking software. When the software indicated poor tracking, the investigator adjusted the endocardial trace line manually until an acceptable tracking score was obtained.

Statistical analysis. Continuous data are presented as mean ± SD and were compared using the Mann–Whitney test. By using the Shapiro–Wilk test, nonnormality was found for the distribution of race time. Therefore, variables were related to race time using Spearman rank correlation analysis. Multiple linear regression analysis was performed to identify variables that were independently associated with race time. Feasibility to perform the multivariate analysis was assessed by residuals statistics. Variables with a P value ≤0.01 in univariate analysis were included in the multivariate model. A P value of less than 0.05 was considered statistically significant.

RESULTS

Of 39 study participants, 38 (97%) IM-ATHL completed the IM race successfully. Average total race time among the finishers was 684 ± 89 min, with race results ranging from 575 to 943 min.

Clinical characteristics and anthropometric measurements of IM finishers are shown in Table 1. Among the 38 subjects included in this analysis, 32 (84%) were men. Average race time was longer in women compared with men (female ATHL: 795 ± 121 min vs male ATHL: 663 ± 65 min, P = 0.007). Among the anthropometric measurements, only percent body fat was significantly correlated with race time.

The training characteristics and their association with total race time are presented in Table 2. The only training parameter that showed a significant correlation with IM performance was the speed in running training.

Echocardiographic parameters of IM finishers and their correlations with race time are summarized in Table 3. Among the structural parameters, LV myocardial mass index showed a moderate correlation with race performance. For RV end-diastolic area, a strong association was found (Table 3, Fig. 1). The correlation with race time remained strong when RV end-diastolic area was indexed for body surface area (11.7 ± 2.0 $cm^2{\cdot}m^{-2}$, $\rho = -0.53$, $P < 0.001$). Indexed LV end-diastolic diameter (2.8 ± 0.3 $cm{\cdot}m^{-2}$, $\rho = -0.14$, P = 0.41) and LV septal wall thickness (9.7 ± 1.4 mm, $\rho = -0.27$, P = 0.1) were not significantly related to the race result. Except for RV fractional area change that showed a borderline association

TABLE 2. Training parameters of IM finishers and correlations with race time.

Parameter	Mean ± SD	Range	Correlation with Race Time	
			Spearman ρ	P
Years as triathlete	6.5 ± 4.4	1–18	0.13	0.44
Weekly training volume (h)	13.5 ± 3.5	7–20	−0.02	0.89
Weekly swimming hours	2.4 ± 1.1	0–4	−0.20	0.24
Weekly swimming kilometers (km)	6.4 ± 3.3	0–17	−0.20	0.24
Speed in swimming training ($km{\cdot}h^{-1}$)	3.0 ± 0.4	1.8–4.0	−0.18	0.30
Weekly cycling hours	7.3 ± 2.7	2–12	0.07	0.66
Weekly cycling kilometers (km)	206 ± 77	50–350	0.07	0.67
Speed in cycling training ($km{\cdot}h^{-1}$)	29 ± 3	23–35	−0.27	0.12
Weekly running hours	3.7 ± 0.9	2–5	0.02	0.92
Weekly running kilometers (km)	41.0 ± 9.8	20–60	−0.04	0.83
Speed in running training ($km{\cdot}h^{-1}$)	11.7 ± 1.2	9.5–14.5	−0.52	0.002

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TABLE 3. Echocardiographic parameters of IM finishers and correlations with race time.

Parameter	Mean ± SD	Range	Correlation with Race Time	
			Spearman ρ	P
LVEDVI (mL·m^{-2})	70 ± 14	41 to 114	−0.31	0.06
LVMMI (g·m^{-2})	98 ± 24	66 to 197	−0.42	0.009
LVEF (%)	63 ± 5	53 to 75	0.09	0.60
LV GLS	−21 ± 3	−27 to −16	−0.09	0.58
LV E velocity (cm·s^{-1})	80 ± 15	55 to 116	−0.01	0.97
LV A velocity (cm·s^{-1})	50 ± 13	23 to 89	0.21	0.21
LV e′ septal (cm·s^{-1})	11 ± 2	5 to 16	−0.14	0.41
LV e′ lateral (cm·s^{-1})	15 ± 4	6 to 24	0.12	0.47
LA volume index (mL·m^{-2})	36 ± 11	16 to 65	−0.07	0.67
RV end-diastolic area (cm^2)	22 ± 4	15 to 28	−0.64	<0.0001
RV FAC (%)	45 ± 7	28 to 59	−0.33	0.05
RV GLS	−24 ± 3	−32 to −18	−0.003	0.98
RV s′ (cm·s^{-1})	15 ± 3	9 to 20	−0.20	0.23
RV e′ (cm·s^{-1})	13 ± 3	6 to 20	−0.16	0.35
RA volume index (mL·m^{-2})	33 ± 9	18 to 59	−0.27	0.10
Systolic RV/RA gradient (mm Hg)	18 ± 4	10 to 25	0.03	0.88

LV, left ventricular; LVEDVI, LV end-diastolic volume index; LVMMI, LV myocardial mass index; LVEF, LV ejection fraction; GLS, global longitudinal strain; E, early mitral inflow; A, atrial mitral inflow; e′, early diastolic annular velocity; LA, left atrial; RV, right ventricular; FAC, fractional area change; s′, systolic peak annular velocity.

with performance, functional parameters of the LV and the RV exhibited no significant correlation with race time (Table 3). This was true also for LV E/A (1.7 ± 0.3, ρ = −0.23, P = 0.18), LV E to early diastolic annular velocity (e′) (6.3 ± 1.5, ρ = 0.03, P = 0.86), RV E/A (1.9 ± 0.6, ρ = −0.04, P = 0.82), and RV E/e′ (4.3 ± 1.3, ρ = −0.04, P = 0.83), as well as for regional functional parameters of the RV as assessed by longitudinal strain imaging (basal RV free wall strain: −25.1 ± 5.3, ρ = 0.09, P = 0.6; midventricular RV free wall strain: −28.6 ± 4.5, ρ = −0.003, P = 0.99; apical RV free wall strain: −29.7 ± 3.8, ρ = 0.06, P = 0.7).

In multivariate analysis, including those parameters with a clearly significant relation to race time in univariate testing, RV end-diastolic area and percent body fat were independent predictors of IM performance, whereas sex, LV muscular mass index, and speed in running training did not show an independent association (Table 4). When the multivariate analysis was recalculated using indexed instead of absolute RV end-diastolic area as a variable, only indexed RV end-diastolic area remained independently associated with IM race time (β = −19.0, 95% confidence interval = −36.6 to 1.7, P = 0.04, adjusted R^2 = 0.56).

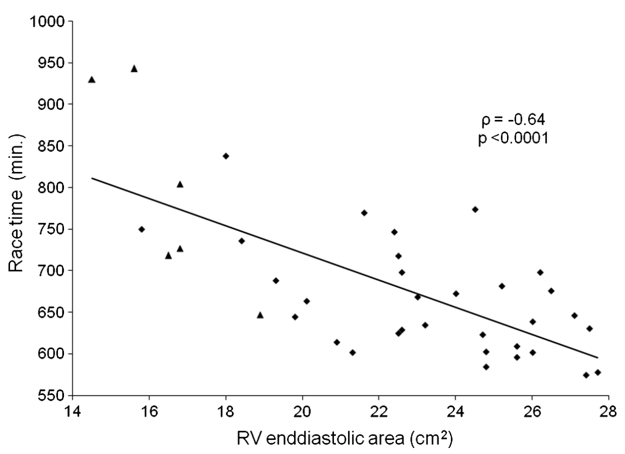

FIGURE 1—Correlation of race time and RV end-diastolic area in IM finishers. Correlation between RV end-diastolic area and race time in 38 amateur IM triathletes successfully finishing the competition. Triangles indicate female and squares male athletes.

DISCUSSION

In this study, RV end-diastolic area was the strongest predictor of race time in amateur IM-ATHL. Other parameters closely related to race performance were sex, percent body fat, speed in running training, and LV muscle mass. In multivariate analysis, only RV end-diastolic area and percent body fat were independently related to IM race time. RV remodeling may thus be an important yet underestimated component of athletes' heart adaptation in IM-ATHL that may potentially be regarded as a marker of successful preparation for IM competitions.

Training specifics, anthropometric measurements and IM result. Preparation for an IM triathlon requires intensive endurance training that results in physical adaptation. To date, there are few data in the literature on prediction of IM race time by anthropometric measures and training characteristics. In recent studies performed in male IM-ATHL, a positive correlation between percent body fat and race time was observed (14,16,17). With regard to training characteristics, older studies suggested that training distances may have the largest effect on IM race performance and that training intensity may be less important (11,31).

In a recent study performed in 184 male amateur IM-ATHL participating and finishing the Ironman Switzerland in 2009 or 2010, a medium to large effect size was found for the

TABLE 4. Multivariate analysis of predictors of race time.[a]

Variable	β	95% Confidence Interval	P
Sex	21.5	−83.6 to 126.6	0.68
Percent body fat	6.8	1.1 to 12.6	0.02
Speed in running training (km·h^{-1})	3.9	−21.4 to 29.1	0.76
LV myocardial mass index	−0.5	−2.0 to 0.9	0.44
RV end-diastolic area	−16.7	−27.3 to −6.1	0.003

[a]Adjusted R^2 = 0.64.
LV, left ventricular; RV, right ventricular.

APPLIED SCIENCES

correlation between total race time and body mass, body mass index, sum of skinfolds, and percent body fat. Among these anthropometric measurements, percent body fat was the best predictor of race performance. In the same study, both speed in training and the weekly training distances were related to race time. However, contrarily to pervious investigations, training paces showed larger effect sizes for their relationship with the total race result than training volumes (17). Similarly, the present study conducted in a smaller sample of IM-ATHL finishing the Ironman Switzerland in 2010 showed significant univariate correlations of IM race performance with percent body fat and speed in running training. These findings on anthropometric measurements and training characteristics imply that the sample investigated in the present study seems to be a representative group of amateur IM-ATHL.

Predictors of race results by cardiac remodeling. There are limited data available on the relationship between cardiac adaption to endurance training and physical performance. In an analysis of 247 male Japanese 100-km ultramarathon participants, race time was predicted by LV diameter (29). In a study performed in elite runners engaged in intense athletic conditioning for a 3-yr period, training resulted in a simultaneous increase in race performance and end-diastolic LV diameter, showing a close association between the changes of the two variables (23). Likewise, LV end-diastolic diameter was significantly correlated to race performance in male elite runners participating in 100 m, 10,000 m, and marathon competitions (24). These data indicate that in runners, LV size seems to be an important echocardiographic parameter for prediction of race time.

Components of athlete's heart remodeling may also be linked to peak oxygen uptake. A study evaluating cardiac magnetic resonance images of a mixed population of ATHL showed an association between maximal oxygen uptake and total heart volume, LV mass, and LV and RV volumes. In multivariate analysis, total heart volume and LV mass were independent predictors of maximal work capacity (37). In cardiac imaging studies including different types of endurance ATHL, peak oxygen consumption was predicted by size and mass of both the left (6,18) and the right ventricle (18), implying that both ventricles may contribute to increased levels of fitness.

Our study is the first to evaluate the role of the heart in prediction of race performance in IM-ATHL. Among the investigated echocardiographic variables, indexed LV muscle mass and RV end-diastolic area were closely related to race time in univariate analysis. RV end-diastolic area was the best predictor of IM performance in this study. Its predictive ability also remained significant in multivariate analysis. The RV may thus play a key role in the cardiac adaptive process related to ultraendurance training in IM-ATHL.

RV remodeling in endurance training. The traditional concept of the athlete's heart has mainly focused on LV remodeling (33,34). However, cardiac adaption in response to endurance training is not confined to the LV; it has been shown that the RV may be similarly involved in this process (7,19,32,35). One reason for this is the series effect. Because the right and the left hearts are in series, the left heart can only pump out to the systemic circulation what it receives from the right heart. Thus, cardiac output is dependent not only on LV but also on RV performance because the RV is an efficient flow generator that affects venous return to the heart (27). Because of its bellows shape and the low muscle mass, increase in size may be a particularly relevant mechanism to increase blood flow through the RV. In endurance ATHL, the RV may even be exposed to a disproportionate exercise load. Exercise may result in increases in pulmonary artery pressures, which seems to be particularly true for highly trained ATHL. Higher stroke volume and cardiac output are thought to be major contributors to the observed increase in pulmonary pressures, indicating that the RV may be exposed to a relative volume and pressure overload in endurance ATHL (8). In a recent study, the RV exhibited a relatively greater increase in estimated end-systolic wall stress during exercise than the LV. The increases in RV wall stress seemed to be related to the intensity of the performed exercise (19). Strenuous endurance training may thus lead to pronounced RV remodeling in ATHL, which in turn may reflect their level of fitness. Potentially, this may be particularly true for the specific group of IM-ATHL that are involved in ultraendurance training combining both dynamic and static elements. However, further studies will be needed to test this hypothesis.

Limitations. Our study was performed in a relatively small group of amateur IM-ATHL willing to undergo an echocardiographic assessment the day before the competition. However, the participants of this study achieved a similar race time on average and exhibited comparable anthropometric data as a previously investigated larger group of recreational IM-ATHL (17).

Amateur IM-ATHL are less well trained than their professional counterparts. The fitness level of the investigated population may have affected the observed findings. Therefore, results of our study cannot necessarily be extrapolated to IM-ATHL in general. Moreover, parameters associated with race performance may be different in other types of ultraendurance ATHL.

This study involves predominantly men. Therefore, it remains uncertain whether our findings also apply to female IM-ATHL. However, sex was not a significant factor in the multivariate analysis. Moreover, the close association between RV end-diastolic area and race time seems to be present irrespective of athletes' sex (Fig. 1).

As recently published, we frequently observed structural changes in the remodeled hearts of the investigated IM-ATHL that may resemble inherited cardiomyopathies, such as LV noncompaction or arrhythmogenic RV cardiomyopathy (7). Because no family screening was performed in these ATHL, we cannot completely exclude that familial cardiomyopathy might have been present. However, compared with healthy controls, IM-ATHL exhibited no signs of impaired cardiac function as assessed by conventional or global and regional 2-D strain derived echocardiographic parameters. This was true also for the subset of ATHL that exhibited structural alterations (7). Moreover, a family history of cardiomyopathies or of sudden cardiac death was absent in all study participants. Therefore, it seems to be very unlikely that inherited cardiomyopathies caused the frequently documented structural alterations.

CONCLUSIONS

In the evaluated group of recreational IM-ATHL, RV end-diastolic area was the best predictor of race performance. Its association to race time remained highly significant when accounting for possible confounding factors in multivariate analysis. Our data suggest that RV remodeling is an important component of cardiac adaption in IM participants that may potentially reflect the fitness level in these ultraendurance ATHL.

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The authors declare no conflict of interest.

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