

Influence of ABO blood group on sports performance

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Background: Despite being a recessive trait, the O blood group is the most frequent worldwide among the ABO blood types. Since running performance has been recognized as a major driver of evolutionary advantage in humans, we planned a study to investigate whether the ABO blood group may have an influence on endurance running performance in middle-aged recreational athletes.

Methods: The study population consisted of 52 recreational, middle-aged, Caucasian athletes (mean age: 49±13 years, body mass index, 23.4±2.3 kg/m²), regularly engaged in endurance activity. The athletes participated to a scientific event called “Run for Science” (R4S), entailing the completion of a 21.1 km (half-marathon) run under competing conditions. The ABO blood type status of the participants was provided by the local Service of Transfusion Medicine.

Results: In univariate analysis, running performance was significantly associated with age and weekly training, but not with body mass index. In multiple linear regression analysis, age and weekly training remained significantly associated with running performance. The ABO blood group status was also found to be independently associated with running time, with O blood type athletes performing better than those with non-O blood groups. Overall, age, weekly training and O blood group type explained 62.2% of the total variance of running performance (age, 41.6%; training regimen, 10.5%; ABO blood group, 10.1%).

Conclusions: The results of our study show that recreational athletes with O blood group have better endurance performance compared to those with non-O blood group types. This finding may provide additional support to the putative evolutionary advantages of carrying the O blood group.

Keywords: Sport; physical activity; ABO blood group; performance

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Introduction

The antigens belonging to the ABO blood group are linked to oligosaccharide chains at the surface of the erythrocyte membrane, but also at the surface of many other cell types such as epithelia, endothelia, neurons and platelets (1). The

ABO locus is located at 9q34.2 and encodes for three major allelic forms, i.e., A, B, and O, which ultimately combine to generate four major ABO blood group types in humans (i.e., O, A, B and AB). Each of the A and B alleles synthesize two glycosyltransferase enzymes (conventionally known as

A and B transferases), which function by catalyzing a final step in the production of these two antigens (2). Unlike these two alleles, the O allele synthesizes an inactive form of glycosyltransferase, which leaves the precursor H antigen unaltered.

Despite being a recessive trait, the O blood group is the most frequent ABO blood type worldwide, with an overall prevalence of 49% in blacks, 44% in Caucasian populations and 43% in Asians (2). This apparent paradox has been tentatively explained by a number of putative evolutionary advantages that the O blood group type may confer to the carriers compared to subjects bearing non-O blood groups (1). Since running performance and economy, which have been refined over a period of nearly 2 million years, have been now recognized as major drivers of evolutionary advantage in humans and other animal species (3), we planned a study to investigate whether the ABO blood group type may have an influence on endurance running performance in middle-aged recreational athletes.

Methods

Study design

The study population consisted of 52 recreational, middle-aged, Caucasian athletes (mean age, 49±13 years; body mass index, 23.4±2.3 kg/m²), regularly engaged in endurance activity (mean training regimen, 257±198 min/week). None of these athletes had acute or chronic diseases at the time of the study, they did not report the intake of drugs before the run and all avoided to perform demanding physical exercise for a period of 48 h before the trial. All athletes voluntarily participated in the scientific event called “Run for Science” (R4S) (4), the full details of which have been described elsewhere (5). Briefly, R4S is a scientific research project endorsed by the University of Verona (Italy) and supported by many other worldwide research organizations, entailing the completion of a 21.1 km (half-marathon) run under competing conditions. The start of the run was officially given at 09:00 a.m. and the route developed on a relatively flat route (i.e., 35 m vertical gain; 1.8% maximal slope). The weather conditions on the day of the event (i.e., April 2, 2017) were as follows: partially cloudy day, temperatures comprised between 14–19 °C and humidity between 50–73%; index of ambient ultraviolet radiation, 0.4–3.1. The athletes were allowed to drink ad libitum during the run, but abstained ingesting food until crossing the finishing line. The ABO blood type status of the participants was

provided by the Service of Transfusion Medicine of the University Hospital of Verona (Italy).

Statistical analysis and ethics approval

The potential associations among physiological variables and running time was tested with univariate analysis (Spearman’s correlation). Multiple linear regression analysis with logarithmic transformation of data was then used for establishing the potential associations between blood group types and running time, which was entered as a dependent variable. More specifically, the physiological variables that were found to be significantly associated with running time in univariate analysis (i.e., $P < 0.05$) were entered into the model as independent variables along with the ABO blood group. The ABO blood group was entered as a dichotomous variable (i.e., O and non-O blood groups). The statistical analysis was performed using Analyse-it (Analyse-it Software Ltd, Leeds, UK). Before being enrolled in the study, all the volunteers provided a written consent. The study has been approved by the local Ethical Committee (Department of Neurological, Neuropsychological, Morphological and Movement Sciences, University of Verona) and was performed in accordance with the Declaration of Helsinki.

Results

The ABO blood group of the athletes was distributed as follows: A, n=25 (48%); O, n=20 (38%); B, n=5 (10%); and AB, n=2 (4%). All athletes successfully completed the 21.1 km run, with a mean running time of 1h 52 min and 35 sec (\pm a standard deviation of 20 min and 00 sec). In univariate analysis, running performance was found to be significantly associated with age and weekly training, whereas no association was found with body mass index (*Table 1*). In multiple linear regression analysis, age and weekly training remained significantly associated with running performance, but also the ABO blood group was found to be independently associated with the running time (*Table 2*). More specifically, O blood group athletes performed better than those with non-O blood groups. Overall, age, weekly training, and O blood group type explained 62.2% of the total variance of running performance (age, 41.6%; training regimen, 10.5%; ABO blood group, 10.1%) (*Figure 1*).

Discussion

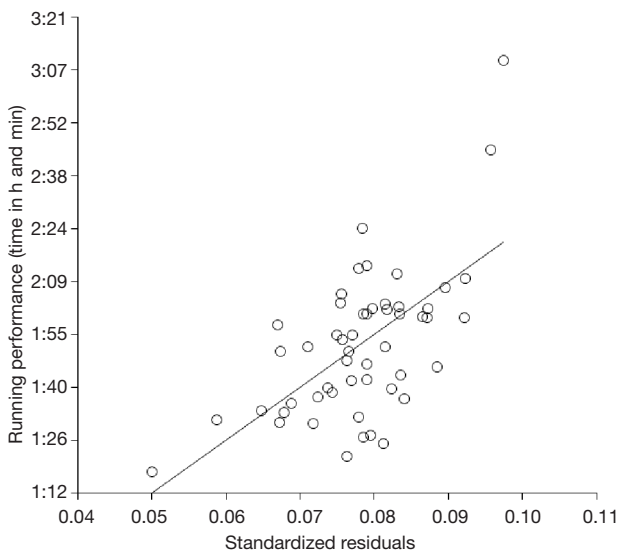
The physiological function of ABO blood group in humans

Table 1 Univariate analysis for identifying significant physiologic predictors of running performance during a 21.1 km half-marathon run

Variable	Correlation
Age	$r=0.41$ (95% CI, 0.16 to 0.62); $P=0.002$
Body mass index	$r=0.25$ (95% CI, -0.03 to 0.49); $P=0.075$
Weekly training	$r=-0.35$ (95% CI, -0.59 to -0.08); $P=0.039$

Table 2 Multiple linear regression analysis for identifying independent predictors of running performance during a 21.1 km half-marathon run

Variable	Correlation
Age	0.028 (95% CI, 0.016 to 0.040); $P<0.001$
Weekly training	-0.007 (95% CI, -0.014 to -0.001); $P=0.029$
ABO blood group	-0.007 (95% CI, -0.013 to -0.001); $P=0.047$

**Figure 1** Multiple linear regression analysis of significant predictors (i.e., age, weekly training and ABO blood group) of running performance during a 21.1 km half-marathon run.

is still a mystery. Despite some hypotheses have been made, no definitive evidence about a putative biological role is available. After over a century of research, it is now clear that having one specific blood group type may carry important consequences on health and wellbeing (2).

Despite being a recessive trait, some good reasons may be brought to justify the larger prevalence of O blood group in humans (2). One reasonable explanation is the protection that this blood group may exert against the risk of developing some of the most frequent human

pathologies (6), thus including cancer (7), cardiovascular disease (8), diabetes (9) and venous thrombosis (10). The recent evidence that women with non-O blood groups are at increased risk of pre-eclampsia brings additional support to the evolutionary advantages of having O blood group type (11). Interestingly, Cvjeticanin and Marinkovic observed that the frequency of the O blood type was high (72.2%) in elite water polo players, whereas the frequencies of the A and B blood types were low and AB was absent (12).

Besides these observations, the results of our investigation pave the way to another fascinating hypothesis, which was not been formally tested before because no previous studies have investigated the relationship between endurance performance and ABO blood group types to the best of our knowledge. The evidence emerged from our study that individuals with O blood groups have better performance in endurance running (i.e., approximately 10% better than subjects carrying other blood groups) may evoke another evolutionary advantage that the O blood group may confer to humans. More specifically, a deep analysis of the structural and physiological features characterizing endurance running ability has recently contributed to unmask many aspects of the genus Homo, which would ultimately confer more sustained endurance running capability compared to other primates (13). These aspects especially include long legs with tendons attaching short muscle fibers to the bones, a typical plantar arch of the feet, short toes, specific muscles conformation, anthropomorphic alterations of hips and shoulders, sweat glands, reduced hair mass, mouth breathing and a body suited for a more efficient heat dissipation (13). It is hence now undeniable that improved performance in

endurance running has played an essential role for early mankind in capturing food (i.e., persistence hunting), reaching carcasses before other vertebrate scavengers, and even making warriors more likely to survive in the battlefield (3,14). Throughout human history, therefore, having O blood group type may have conferred another survival benefit to the carrier, extending over the reproductive period.

Conclusions

The results of our study show that recreational athletes with O blood group have better endurance performance in running a 21.2 km distance compared to those with non-O blood group types. This finding may hence provide additional support to the putative evolutionary advantages of carrying the O blood group type.

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Footnote

Conflicts of Interest: The authors have no conflicts of interest to declare.

Ethical Statement: The study has been approved by the local Ethical Committee (Department of Neurological, Neuropsychological, Morphological and Movement Sciences, University of Verona) and all the volunteers provided a written consent.

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