Comparison of Energy Expenditure of Youth Playing Tennis During Practice and Match Settings

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Background: Researchers have investigated the energy expenditure of tennis practice and match play in adults but not youth. **Methods:** VO_2 was recorded for 36 youth, ages 9 to 18, during 10-minute bouts of tennis practice and match play. A GLM was used to compare VO_2 between practice and match play and among age groups (9–12 years, 13–15 years, and 16–18 years); also to compare the difference in adult and child-derived MET values (ΔMET). **Results:** VO_2 was higher for tennis match play vs. practice ($P < .05$) and there was a trend for 16 to 18 year olds having lower VO_2 than 9 to 12 year olds ($P = .055$). ΔMET did not differ between settings but varied by age group ($P = .004$); it was highest in 9- to 12-year-olds and lowest in 16- to 18-year-olds. **Conclusions:** Youth expend more energy while playing a tennis match than practice, regardless of age. Child-derived MET values equaled those of adults once youth reached ages 16 to 18.

Keywords: oxygen uptake, MET, children

Tennis is a popular sport worldwide with approximately 9.5 million children participating world-wide,¹ yet our knowledge of the energy expenditure (EE) during match play and practice is limited. Studies on the EE of tennis have reported moderate and high levels of EE.^{2–6} This wide range can be related to, complexity of the sport that has both anaerobic and aerobic demands,⁵ the number of strokes per point,⁴ duration of points which could be less than 10 seconds or much longer,⁵ skill level of the participant,⁷ whether the match was singles or doubles^{2,6} and overall effort given by the player. To date, all of this data has been reported for adults.

We know little about the EE of youth playing tennis. A review of the literature resulted in no studies of actual tennis play in youth; however, there are some recent reports of EE in tennis style video games.⁷ From a health perspective, an understanding of the EE of youth playing tennis is important to allow us to compare it to other forms of physical activity and make accurate exercise prescriptions based on the data.

The *Compendium of Physical Activity for Adults* estimates the EE of tennis in terms of increments in resting metabolic rate (MET), which is equivalent to 3.5 ml/kg/min.⁹ The Compendium provides MET values for general singles play (7 METs), singles match play (8 METs) and doubles match play (6 METs). Ridley et al¹⁰ in the *Compendium of Physical Activity for Youth* did not report any direct measures of EE for youth playing tennis. Youth typically have higher resting EE (REE) than adults and their REE is age dependent.⁷ Likewise, the energy cost of locomotion is greater in children than adults, resulting in children having lower economy.⁷ Thus, the use of an adult-derived MET value may not be correct. In addition, tennis skill may be different for children than adults and the weight of a tennis racket is proportionally greater in children than adults causing a greater EE in children.

The aims of this investigation were to 1) describe the oxygen uptake of youth playing tennis in practice and match settings, 2) compare values between these settings, 3) compare the difference

between adult- and child-derived MET values during practice and match settings, and 4) to examine age-related trends in these variables.

Methods

Youth and their parents were recruited from the community via flyers. They first contacted the researchers by phone and were asked about tennis experience. Youth with no experience were eliminated from participation. This resulted in 36 9- to 18-year-old youth; 15 girls and 21 boys. They were divided into 3 age groups: 9 to 12 years, 13 to 15 years, and 16 to 18 years. Because of uneven distribution of sexes, they were combined within age-groups. In addition, we had few young youth with tennis experience, which explains the variety of ages in the youngest group. Physical characteristics are presented by age group in Table 1. Although 36 youth participated in the practice sessions, during match play 1 subject was eliminated from each of the upper age groups because of unusable data.

Youth and their parents came to the Applied Physiology Laboratory where they were introduced to the study protocol and the parents signed a consent for their children to participate and

Table 1 Mean $\pm$ SD Physical Characteristics of the Participants Presented by Age Group

Characteristics	Age group (years)		
	9–12	13–15	16–18
n	7	14	15
Age (y)	11 $\pm$ 1	14 $\pm$ 1	17 $\pm$ 1
Height (cm)	154 $\pm$ 11	161 $\pm$ 11	171 $\pm$ 8
Body mass (kg)	45.0 $\pm$ 7.3	54.1 $\pm$ 10.6	69.6 $\pm$ 20.9
Body mass index	18.9 $\pm$ 1.1	20.1 $\pm$ 3.0	23.8 $\pm$ 7.2
Body mass index percentile	70.8 $\pm$ 15.5	64.0 $\pm$ 25.1	64.3 $\pm$ 24.8

Note. $P < .05$ practice and match play.

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the youth signed an assent. The youth had not eaten, nor exercised for the previous 2 hours. The consent and assent were previously approved by the University's Internal Review Board. After signing, the youth's height and body mass were measured and tennis rackets were sized as accurately as possible. They were then given practice using the Cosmed Portable metabolic system using the appropriate sized mask (Cosmed, Rome Italy). Once the youth were comfortable with the metabolic system it was removed and calibrated with known gases, while a 3-L syringe was used to calibrate the flowmeter.

The youth were then refitted with the metabolic system, and then seated in a quiet room for 10 minutes followed by a measurement of resting oxygen uptake (VO_2 , ml/kg/min) for 15 minutes. Once resting measures were completed they walked ~200 m to the tennis court. The youth then participated in 10 minutes of practicing serves and volleying with a research assistant (RA) on the other side of the net. Metabolic rate was measured the entire time. This was followed by a seated rest period of 10 min. At the end of the rest the youth participated in a 10-minute tennis match against the RA, during which metabolic rate was measured. At the end of the measurement period, the metabolic unit was removed and the youth returned to the Laboratory.

Data Management

The metabolic data from the COSMED system was downloaded and converted to an Excel data set. From the resting data, minutes 1 to 5 and 14 to 15 were removed and the remaining averaged to obtain REE. For the practice and match data the first 3 and the last 1 minute of resting data were removed and the remaining minutes were averaged for further analyses. Metabolic equivalents were then computed 2 ways. A youth MET (MET_Y) was calculated by dividing the VO_2 (ml/kg/min) from tennis by the participants REE. An adult MET (MET_A) was also developed by dividing the tennis VO_2 by 3.5 ml/kg/min which is the value assigned to the adult MET.⁸ ΔMET was created by subtracting the MET_Y from the MET_A .

Means and standard deviations were computed for all variables by the 3 age groups. A general linear model (GLM) was used to compare the practice and match VO_2 values between and within the age groups, as well as to compare the practice and match ΔMET between age groups with an a priori value of $P < .05$. Tukey HSD post hoc tests were used to examine group differences. Statistical analyses were completed using SPSS Statistics (Version 21).

Results

Table 2 presents the mean and standard deviations for VO_2 of youth playing tennis in practice and match setting, according to age group. VO_2 was significantly higher during match settings than during practice ($P = .034$). VO_2 differences according to age group approached statistical significance ($P = .055$), with a trend for the 16 to 18 year old age group have lower VO_2 values than the youngest youth. There was no significant interaction between the setting of play (practice or match) and age group ($P > .05$) for VO_2 .

The data for the MET_Y and MET_A as well as the ΔMET ($\text{MET}_A - \text{MET}_Y$) are displayed in Table 3. There was a significant difference in ΔMET according to age group ($P = .003$) and post hoc analyses revealed that the youngest group had a greater ΔMET than the oldest age group ($P = .004$), while the difference between the 13- to 15-year-olds and 16- to 18-year-olds approached statistical significance ($P = .053$). There was no difference in MET or ΔMET between tennis and match settings, no difference in MET accord-

Table 2 Mean $\pm$ SD Oxygen Uptake Values of Youth in Tennis Practice and Match Settings Presented by Age Group

VO_2 (ml/kg/min)	Age groups (years)		
	9–12	13–15	16–18
Rest	4.4 $\pm$ 0.5	3.9 $\pm$ 0.5	3.5 $\pm$ 0.5
Practice	26.1 $\pm$ 4.9	27.1 $\pm$ 6.8	22.6 $\pm$ 7.0
Match play	27.5 $\pm$ 2.6	28.4 $\pm$ 6.1	23.6 $\pm$ 6.1

Note. $P < .05$ practice and match play.

Table 3 Youth (MET_Y), Adult (MET_A), and ΔMET ($\text{MET}_A - \text{MET}_Y$) for the 3 Age Groups During Practice and Match Play

	Age groups [†] (years)		
	9–12	13–15	16–18
Practice			
MET_Y	5.9 $\pm$ 0.7	6.8 $\pm$ 1.4	6.4 $\pm$ 1.6
MET_A	7.5 $\pm$ 1.4	7.7 $\pm$ 2.0	6.5 $\pm$ 2.0
ΔMET	1.5 $\pm$ 0.9	0.9 $\pm$ 1.1	0.1 $\pm$ 0.9
Match play			
MET_Y	6.3 $\pm$ 0.5	7.3 $\pm$ 1.4	6.8 $\pm$ 1.8
MET_A	7.8 $\pm$ 0.8	8.1 $\pm$ 1.7	6.8 $\pm$ 1.7
ΔMET	1.5 $\pm$ 0.8	0.9 $\pm$ 1.1	-0.1 $\pm$ 0.9

[†] $P < .05$, ΔMET between 9–12 and 16–18 groups.

ing to age and no interaction between the setting of play and age group ($P > .05$).

Discussion

Our results showed that regardless of age group, youth had a higher VO_2 and MET values during match play than during practice. Although the mean VO_2 values for practice and match only differed by ~1 ml/kg/min, the additional caloric expenditure during matches could be sizeable if continued for long periods of time. This in turn, could have implications for energy balance of youth playing tennis. The higher VO_2 during match play may be related to an increased intensity of play, greater sympathetic tone associated with the perception of competition or extra effort to return the ball compared with practice.

The VO_2 of the 16- to 18-year-olds was 16% to 20% less than the younger youth during match play. The trend for the oldest youth to have lower VO_2 than the youngest youth could be indicative of improved economy due to better technique (less extraneous movements), or less of an effort to maneuver the tennis racquet as it would weigh proportionally less as the youth grew. As the literature on youth tennis is sparse, it is not possible to compare these results to similar studies; however, the mean VO_2 values were lower than those reported for adults performing tennis drills.³

The difference between adult and youth MET values (ΔMET) for 9- to 12-year-olds was 21% for practice and 24% for match play.

This Δ MET was negligible for 16- to 18-year-old youth, indicating that the latter age group showed similar MET values to adults. Lyden et al also noted differences between MET values listed in the youth Compendium and those measured in their youth participants.¹¹ Likewise, these researchers observed lower MET values in younger children compared with older youth for several physical activities, including tennis played on a Nintendo Wii.¹¹ This highlights the need for different MET classifications for differing aged youth.

Limitations include the small sample size in the 9- to 12-year-old age group, the participation of only Caucasian youth and analysis of data with sexes combined. However, the percentage of males and females in each age group was similar. In addition, we acknowledge that the addition of heart rate data and VO_2max values would enhance the ability to gauge relative intensity. Strengths of the study include the inclusion of a wide age range of youth and data from tennis practice and match play.

In conclusion, 9- to 18-year-old youth expend more energy during tennis match play compared with practice. In addition, youth-derived MET values are less than adult-derived METS during tennis match play and practice but these differences disappeared once youth neared adulthood (16–18 years old). This suggests that adult MET values should not be assigned to youth less than 16 years of age.

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