Journal of Physical and Outdoor Education
Vol. 5 No. 1, April 2023, pp. 77-88

The Severity Factor Of Injury Risk In Tennis Athletes

Didik Rilastiyo Budi[1], Arfin Deri Listiandi[2], Kusnandar[3], Panuwun Joko Nurcahyo[4]

[1,2,3,4]*Department of Physical Education, Faculty of Health Sciences, Universitas Jenderal Soedirman , Indonesia*

Abstract

Body composition and shape according to ideal Body Mass Index (BMI) conditions are crucial factors for tennis athletes to reach high performance and avoid the risk of injury. This study aimed to determine the correlation between Body Mass Index (BMI) and the injury rate in tennis athletes in Banyumas Regency. The research instrument used a body mass index (BMI) and Functional measurement test. The measurement profile is strengthened by the athlete's injury archives data using an injury questionnaire. The research method uses the Correlational method. Data analysis used normality test, linearity test, and correlation test to comprehend the level of relevance between Body Mass Index (BMI) and the prevalence of injury in tennis athletes. Identification of Body Mass Index (BMI) and risk of injury in tennis athletes is essential for coaches to design an accurate training program for athletes to achieve high performance during training and competitions. The results showed that the significance value was 0.000 or stated a relationship or relevance between BMI and the risk of injury in tennis athletes. BMI results show that the average BMI is in normal conditions (22.36), and FMS results for the risk of injury to tennis athletes are in the category of having a low risk of injury. The results of this study provide information about the importance of the ideal composition of Body Mass Index (BMI) to avoid the possibility of sports injuries caused by excessive body weight. Identification of Body Mass Index (BMI) and risk of injury in tennis athletes is essential information for coaches to design the right training program for athletes to achieve high performance during training and matches.

Keywords: Body Mass Index (BMI), Injury Risk, Functional Movement Screening, Tennis Athletes

INTRODUCTION

Exercise is essential for everyone to maintain their body health. Programmed physical activity and exercise are ways to maintain fitness levels and health status (Monteiro *et al.*, 2019; Suhartoyo *et al.*, 2019; Budi *et al.*, 2021; Widyaningsih *et al.*, 2021). Regular and programmed exercise is the principal determining factor for Body Mass Index (BMI). Body mass index (BMI) is generally defined as measuring body condition by measuring body fat levels.

Body Mass Index is the result of a calculation of body weight (kg) divided by height (m) squared (Arjuna, 2020). Furthermore, (Budi, Listiandi, *et al.*, 2020)) explained

Correspondence author: Didik Rilastiyo Budi, Universitas Jenderal Soedirman, Indonesia.
Email: didik.rilastiyo.budi@unsoed.ac.id

that Body Mass Index (BMI) is a method for measuring body compositi on and categorizing athletes' body weight at the level of underweight, average, or overweight. In its development, Body Mass Index (BMI) has become a vital study material as an indicator of determining health status. An example is the measurement of the Body Mass Index to determine the nutritional status of school children (Nurhasan and Cholil, 2014).

Research results of Kemenkes (2013) showed that 11.2% of Indonesian children (aged 5-12 years) were underweight, 30.7% in the normal, and 18.8% in the overweight/obesity category. Adolescents (13-18 years) and adults (above 18 years) are periods of nutritional vulnerability. The condition of nutritional vulnerability is influenced by: First, adolescents require higher nutrients due to increased physical growth. Second, there are changes in lifestyle and eating habits. Third, adolescents have special nutritional needs, for example, the needs of athletes. Overnutrition in adolescents is characterized by relatively excessive body weight compared to the age or height of adolescent peers due to excessive fat accumulation in body fat tissue (Kurdanti *et al.*, 2015).

Riskesdas data in 2013 showed that adolescents aged 13-18 years had a prevalence of 8.3% and 2.5% of overweight and obesity, respectively. The highest prevalence of overweight and obesity in adolescents in Indonesia is found in adolescents in Surabaya. The prevalence of overweight reaches 8.9%, and obesity reaches 3.9%. This figure is slightly higher than the prevalence in Indonesia as a whole (Kemenkes, 2013). The percentage of body fat based on gender as the research results shows that the percentage of fat in adolescent girls is greater than that of boys (Nufus, 2015; Widanita *et al.*, 2019). The prevalence of obesity in years based on data shows that at the age of 16-18 years nationally has obesity prevalence of 1.4%. It was found that 16-18 years of adolescents in 11 provinces in Indonesia had obesity levels above the national prevalence (R.P Jawa Tengah, 2010). One of the provinces with a high percentage of obesity in adolescents is Central Java. The results showed that the prevalence of underweight adults was 17.2%, normal was 65.6%, overweight was 8.1%, and obesity was 8.9%. More specifically, Banyumas Regency has a percentage of adolescent obesity of 20.8%, with 13.9% male and 27% female. This composition delivers Banyumas ranked 6th at the Central Java level for adolescent obesity rates.

Multiple studies on Body Mass Index (BMI) and nutritional status in Banyumas Regency have been carried out to comprehend the community's health condition and nutritional status. Based on various research results regarding nutritional status and Body Mass Index (BMI) from the age of 2-20 years, it was concluded that there was a tendency for most children to be categorized as underweight, overweight, and obese. This tendency

including research data conducted on athletes in numerous sports, such as tennis, volleyball, swimming, and gymnastics. The research results on elementary school students in Banyumas Regency showed that 9.9% of students were underweight, and 12.2% of them were in the obese category (Purnamasari, Dardjito and Kusnandar, 2015). Research on Body Mass Index (BMI) in elementary students-athletes in Purwokerto showed 64.29% in the underweight category, 21.43% in the normal category, and 14.29% in the overweight category (Budi, Listiandi, *et al.*, 2020). The results of another study conducted by (Kusnandar *et al.*, 2020) show that volleyball athletes in college have an underweight body mass index (BMI) of 20%, average 50%, and overweight 30%.

The research results on adolescent tennis athletes, especially 12-20 years old, have a high risk of injury (B. M. Pluim, 2014; S. Dines, Joshua et al., 2015; Oosterhoff et al., 2019; Budi, Agustan, *et al.*, 2020). The injury is caused by training and competition factors, but a more specific analysis related to the cause of injury to tennis athletes is an imbalance in body composition that is less than ideal. In this case, the body mass index (BMI) condition has not been exploring in more detail yet.

The characteristics of court tennis, which tend to be fast, high intensity, and mobility, require ideal physical conditions and body composition (Oosterhoff et al., 2019; Budi, Syafei, *et al.*, 2020; Meffert *et al.*, 2021). Tennis is a sport characterized by the application of complex playing techniques and requires excellent body fitness (Maheshwari *et al.*, 2022). Judging from the various data showing the correlation between ideal BMI and the possibility of injury and sports performance, research is needed to examine the relevance of BMI to the level of injury in tennis athletes in the Banyumas Regency.

Based on the problems and various research results conducted by researchers, it is crucial to know the relevance between Body Mass Index (BMI) and Injury Levels of Tennis Athletes in Banyumas Regency. This study will reveal the profile of Body Mass Index (BMI) and records of tennis athlete injury so that appropriate steps can be practiced to minimize the risk due to excess BMI and the application of appropriate exercise programs to reduce the high rate of injury to junior and adolescent athletes in Banyumas Regency. The purpose of this study is to explore the relevance or relation between Body Mass Index (BMI) and the risk of injury to tennis athletes in Banyumas Regency, Indonesia. The implication of this research is to provide primary data in athlete development programs to achieve high performance and achievement in the tennis sport.

METODE

The research method uses the correlational method. The collecting data is within a series of body mass index (BMI) measurements by comparing height and weight. Measurement of sports injury tests using the Functional Movement Screen (FMS). The Functional Movement Screen (FMS) is a screening tool to evaluate seven fundamental movement patterns in individuals with no current pain complaint or musculoskeletal injury. The research design to find the relationship between the independent variable Body Mass Index (X) and the dependent variable Injury Level (Y) is illustrated in the following figure:

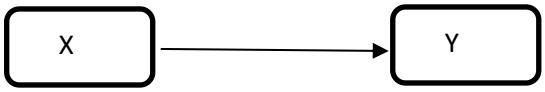

Figure 1 Correlational Research Design

Participants

Determination of research participants using the total sampling technique. Research participants were tennis athletes in Banyumas Regency, totaling 20 people, with 10 male athletes and 10 female athletes. Details of research participants are presented in Table 1 below:

Table 1. Number of Research Participants

No	Participants	Age	Amount	Total
1	Male Athlete	> 18 Years	7	**10**
		16-17 Years Old	3	
2	Female Athlete	> 18 Years	6	**10**
		16-17 Years Old	4	
Total Participants				**20**

Procedure/Test protocol/Skill test trial/Measure/Instruments

Measurement of Body Mass Index (BMI) of research participants is to divide the number of body weight in kilograms (kg) with height in meters squared (kg/m2). BMI categorization is determined based on the criteria of the Ministry of Health of the Republic of Indonesia for children aged 2-20 years ((Kemenkes, 2013). The results of BMI measurements in participants are presented in Table 2 below:

Table 2. Criteria for Body Mass Index (BMI)

No.	Criteria	BMI(kg/m^2)
1	Underweight	BMI<18,5
2	Normal	BMI 18,5-25,89
3	Overweight	BMI 25,90-26,99
4	Obesity	BMI > 27

The sports injury measurement instrument uses a Functional Movement Screen (FMS) with test validity, and reliability of 0.81 (Cook *et al.*, 2014; Abraham, Sannasi and Nair, 2015; Bonazza *et al.*, 2017; Marques *et al.*, 2017; Syafei *et al.*, 2020; Akbar and Awalludin, 2021), the type of FMS test is as presented in Table. 3 below:

Table 3. Functional Movement Screening Test Type

No.	FMS Test Type
1	Overhead Squat
2	In Line Lunge
3	Hurdle Step
4	Active Straight Leg Raise
5	Shoulder Mobility
6	Trunk Stability Pushup
7	Rotary Stability

The procedure for testing and measuring Functional Movement Screen (FMS) to participants is utilizing participants carrying out each FMS movement as in Table 3 sequentially and then assessed with a score according to the provisions as presented in Figure 2. below:

Figure 2. FMS Test Score

Another measurement instrument to strengthen the study results is using the questionnaires to track injury records in tennis. The observation and interview research instrument used refers to Joshua *et al.* (2015) and Kekelekis *et al.* (2020), which classifies tennis injuries occurring on the shoulders, hands, and wrists, elbows, stomach, and groin, back, hips, thighs, and ankles, these types of injuries were used as topics for interviews and guidelines for observing sports injuries in junior tennis athletes. The process of assessing the Functional Movement Screen (FMS) movement was carried out by a research team with a total of 3 people with qualifications of sports lecturers who have been involved in various FMS measurements and have experience in conducting FMS assessments on athletes.

Data collection and analysis / Statistical analysis

The research data collection was carried out in three stages; the first stage was filling out a questionnaire about records of injuries that had been experienced, the second stage was measuring height and weight to determine Body Mass Index (BMI). The last stage to determine the risk of injury in tennis athletes is measuring Functional Movement Screen (FMS). Analysis of the data using the SPSS application, by determining the normality test, linearity test, and correlation test to determine the relationship or relevance between Body Mass Index (BMI) and the risk of injury in tennis athletes. The provision of the correlation test is that if the significant value is < 0.05, it is stated that there is a relationship between BMI and the risk of injury to tennis athletes.

RESULTS AND DISCUSSION

Research on the relevance of Body Mass Index (BMI) toward the risk of sports injury using the Functional Movement Screen (FMS) method in tennis athletes in Banyumas Regency was carried out by measuring and categorizing athletes' body mass index, FMS tests on athletes and analyzing at the athlete's injury records. The results of measuring the body mass index concerning tennis athletes are presented in Table 4 below.

Table 4. Body Mass Index (BMI) of Tennis Athletes

No.	Participants	Underweight	Normal	Overweight	Obestity
1	Male Athlete	1	5	2	2
2	Female Athlete	1	4	4	1
	Total	**2**	**9**	**6**	**3**

Based on the results of measurements of research participants, only 45% of tennis athletes had a normal or ideal BMI, while the remaining 10% showed an underweight BMI, 30% of them were overweight, and even 15% of athletes were obese category. The results of BMI measurement are classified as unideal requirements for athletes, although the total average of the tennis athlete's body mass index is quiet in the normal category, which is 22.36. After measuring the body mass index, the next step is to conduct a Functional Movement Screen (FMS) test. The results of the FMS test on tennis athletes in Banyumas Regency are presented in Table 5 below.

Table 5. Risk of Sports Injuries in Tennis Athletes

No	Participants	FMS	
		High Injury Risk	Low Injury Risk
1	Male Athlete	3	7
2	Female Athlete	5	5
Total		**8**	**12**

The Functional Movement Screen (FMS) test results on research participants showed that as many as 40% of participants had a high risk of sports injury, and 60% were at a low level of sports injury risk. The result shows that the overall average risk of sports injury level in tennis athletes in Banyumas Regency was at the level of low risk. The results of measuring Body Mass Index (BMI) and injury risk tests were strengthened by the records of injuries endured by athletes based on research questionnaires. The results of the questionnaire on the records of sports injuries are present in Table 6 below.

Table 6. Tennis Athlete's Sports Injury Records Based on BMI

Type of Injuries	Underweight	Normal	Overweight	Obesity
Shoulder	-	1	2	1
Elbow	1	1	3	3
Arm	1	-	1	2
Back	-	-	1	1
Knee	-	-	1	1
Hamstring	1	1	3	3
Ankle	1	1	3	3
Total	**4**	**4**	**14**	**14**

Based on the results of a questionnaire on the records of sports injuries in tennis athletes in Banyumas Regency, it shows that athletes who have a BMI in the overweight and obese categories have a record of 3.5 times more frequent injuries than athletes who have an ideal BMI. In comparison, the risk of sports injury in tennis athletes with an underweight BMI is equal to tennis athletes with a normal or ideal BMI. It can be concluded that tennis athletes with an ideal BMI have more moderate injury cases than tennis athletes with an overweight and obese body mass index.

Linearity Test

The linearity test determines whether the Body Mass Index variable has a linear relationship with the risk of sports injury in tennis athletes significantly. The data is declared to have a linear correlation if the sig value is > 0.05. The results of the linearity test of the research data are presented in the Table. 8 below.

Table 8. Linearity Test of Research Data

ANOVA Table

			Sum of Squares	df	Mean Square	F	Sig.
IMT FMS	Between Groups	(Combined)	115.569	14	8.255	1.899	.247
		Linearity	80.424	1	80.424	18.498	.008
		Deviation from Linearity	35.145	13	2.703	.622	**.774**
	Within Groups		21.738	5	4.348		
	Total		137.307	19			

Based on the results of the linearity test calculation, the linearity value is 0.774. This figure shows that the BMI and FMS data on research participants are linear because they value > 0.05.

Correlation Test

The correlation test aims to answer research questions regarding the relevance between Body Mass Index (BMI) and the risk of injury in tennis athletes. A correlation test is accomplished by using SPSS. A significant relationship was obtained if the results of the correlation test showed a sig value < 0.05. The results of the correlation are presented in Table 9 below.

Table 9. Correlation Test between BMI and FMS

Correlations			
		IMT	FMS
IMT	Pearson Correlation	1	-.765**
	Sig. (2-tailed)		**.000**
	N	20	20
FMS	Pearson Correlation	-.765**	1
	Sig. (2-tailed)	**.000**	
	N	20	20

The calculation of the correlation test in Table 9 above shows that the BMI and FMS sig values are 0.000, so it can be concluded that there is a significant correlation or relevance between BMI levels and the risk of sports injury in tennis athletes. The better the condition of the body mass index, the smaller the risk of injury to athletes.

The results showed that overall, the condition of the Body Mass Index (BMI) of tennis athletes in Banyumas Regency was normal, but some athletes were overweight and even obese. One of the determining factors for athletes not achieving the ideal BMI is the athlete's non-compliance with the regular exercise program. Based on the results of previous research, it shows that planned exercise is effective in maintaining the body fitness and performance of athletes (Cardoso Marques, 2005; Barber-Westin, Hermeto and Noyes, 2010; Sonal, 2018; Syafei *et al.*, 2019; Fauzi, Hanif and Siregar, 2021). Ideal Body Mass Index is an essential component that needs to be considered by athletes and coaches.

In addition to being related to performance, the Body Mass Index (BMI) possessed by athletes can also impact the possible risk of injury. This statement is confirmed in this study which shows that the Body Mass Index (BMI) with the risk of injury in tennis athletes through the Functional Movement Screen (FMS) test has a significant correlation. Athletes with underweight and normal BMI have a more moderate risk of injury than athletes with BMI composition in the overweight and obese categories. This study supports previous

research, which states that body composition in athletes considerably influences the occurrence of injuries during training and competitions (Ellenbecker *et al.*, 2009; Dines *et al.*, 2015; Richmond *et al.*, 2016). Sports injuries in tennis athletes can influence the athlete's achievement so that the factors that cause injury requirements to be minimized and avoided.

The study results were also strengthened by the injury records of tennis athletes taken from an injury questionnaire. Tennis athletes with overweight and obese BMIs have a more complex injury record than underweight and normal BMIs. Athletes with overweight and obese BMI have a record of Shoulder, Arm, Elbow, Back, Knee, Hamstring, and Ankle Injuries. Based on these facts, athletes need to maintain their body composition in the normal BMI category. In addition to reducing the risk of injury, athletes' ideal body composition can support achieving excellent performance and outstanding performance (Pontaga and Žīdens, 2011; Sedeaud *et al.*, 2014; Fernandez-Fernandez *et al.*, 2019).

Recommendations based on the results of this study are the importance of the appropriate exercise program by the coach to maintain the athlete's body condition in the normal BMI category. Athletes need the motivation to maintain a healthy lifestyle regarding rest patterns, diet, and exercise patterns. Thus athletes will have a normal BMI and avoid a high risk of injury.

CONCLUSIONS

The results showed that the average BMI of tennis athletes in Banyumas Regency was in the normal category. Based on FMS results, the risk of sports injury shows on the minor injury. The results also explained the significant correlation between BMI and risk of injury. In other statements, the better the athlete's BMI, the lower the risk of injury. This study provides information about the importance of the ideal composition of Body Mass Index (BMI) to avoid the possibility of sports injuries caused by excessive body weight. Identification of Body Mass Index (BMI) and risk of injury in tennis athletes is essential information for coaches to design the appropriate training program for athletes to achieve high performance during training and competitions. Further research is expected to examine the condition of BMI with psychological factors and athlete performance during training or competition. Another suggestion is to examine the condition of the injury with psychological factors or performance on the competition.

ACKNOWLEDGMENT

The authors appreciate the Institute for Research and Community Service (LPPM) at Jenderal Soedirman University for supporting the Riset Dasar Unsoed (RDU) scheme research fund.

REFERENCES

Abraham, A., Sannasi, R. and Nair, R. (2015) 'Normative values for the functional movement screentm in adolescent school aged children', *International Journal of Sports Physical Therapy*, 10(1), pp. 29–36. Available at: http://www.ncbi.nlm.nih.gov/pubmed/25709860.

Akbar, Z. and Awalludin (2021) 'Functional movement screening as an assessment in the early childhood', *Journal of Physical Education and Sport*, 21(4), pp. 2432–2439. doi: 10.7752/jpes.2021.s4327.

Arjuna, F. (2020) 'Pengaruh Latihan Sirkuit Dengan Interval Istirahat Tetap dan Menurun Terhadap Komposisi Tubuh Pemain Bola Voli Putri.', *MEDIAKORA*, 19(1), pp. 8–16. doi: https://doi.org/10.21831/MEDIKORA.V19I1.30975.

B. M. Pluim (2014) 'The evolution and impact of science in tennis: Eight advances for performance and health', *British Journal of Sports Medicine*, 48(1), pp. i3–i5. doi: doi: 10.1136/bjsports-2014-093434.

Barber-Westin, S. D., Hermeto, A. A. and Noyes, F. R. (2010) 'A six-week neuromuscular training program for competitive junior tennis players', *Journal of Strength and Conditioning Research*, 24(9), pp. 2372–2382. doi: 10.1519/JSC.0b013e3181e8a47f.

Bonazza, N. A. *et al.* (2017) 'Reliability, Validity, and Injury Predictive Value of the Functional Movement Screen: A Systematic Review and Meta-analysis.', *The American Journal of Sports Medicine*, 45(3), pp. 725–732. doi: https://doi.org/10.1177/0363546516641937.

Budi, D. R., Listiandi, A. D., *et al.* (2020) 'Indeks Masa Tubuh (IMT): Kajian Analisis pada Atlet Renang Junior Usia Sekolah Dasar', *TEGAR: Journal of Teaching Physical Education in Elementary School*. doi: 10.17509/tegar.v3i2.24452.

Budi, D. R., Agustan, B., *et al.* (2020) 'Tennis injury: Analysis and preventions actions among national junior tennis athlete', *International Journal of Psychosocial Rehabilitation*, 24(8), pp. 7922–7933. doi: 10.37200/IJPR/V24I8/PR280805.

Budi, D. R., Syafei, M., *et al.* (2020) 'The significance of exercise method on forehand and backhand groundstroke skills improvement in tennis', *Jurnal SPORTIF: Jurnal Penelitian Pembelajaran*, 6(1), pp. 132–144. doi: https://doi.org/10.29407/js_unpgri.v6i1.13920.

Budi, D. R. *et al.* (2021) 'Cycling during covid-19 pandemic: Sports or lifestyle?', *International Journal of Human Movement and Sports Sciences*, 9(4), pp. 765–771. doi: 10.13189/saj.2021.090422.

Cardoso Marques, M. A. (2005) 'Strength training in adult elite tennis players', *Strength and Conditioning Journal*, 27(5), pp. 34–41. doi: 10.1519/00126548-200510000-00005.

Cook, G. *et al.* (2014) 'Functional movement screening: the use of fundamental movements as an assessment of function', *International Journal of Sports Physical Therapy*, 9(3), pp. 396–409. Available at: http://www.ncbi.nlm.nih.gov/pubmed/24944860.

Dines, J. S. *et al.* (2015) 'Tennis Injuries : Epidemiology ', *J American Academic Orthopaedic Surgery*, 23(3), pp. 181–189.

Ellenbecker, T. S. *et al.* (2009) 'Common injuries in tennis players: Exercises to address muscular imbalances and reduce injury risk', *Strength and Conditioning Journal*,

31(4), pp. 50–58. doi: 10.1519/SSC.0b013e3181af71cb.

Fauzi, D., Hanif, A. S. and Siregar, N. M. (2021) 'The effect of a game-based mini tennis training model on improving the skills of groundstroke forehand drive tennis', *Journal of Physical Education and Sport*, 21(4), pp. 2325–2331. doi: 10.7752/jpes.2021.s4311.

Fernandez-Fernandez, J. *et al.* (2019) 'Age and sex-related upper body performance differences in competitive young tennis players', *PLoS ONE*, 14(9), pp. 1–18. doi: 10.1371/journal.pone.0221761.

J. H. F. Oosterhoff et al. (2019) 'Risk factors for musculoskeletal injuries in elite junior tennis players: a systematic review', *J. Sports Sci. Med*, 37(2), pp. 131–137. doi: doi: 10.1080/02640414.2018.1485620.

Joshua, S. *et al.* (2015) 'Tennis Injuries: Epidemiology, Pathophysiology, and Treatment', *Journal of the American Academy of Orthopaedic Surgeons*, 23(3), pp. 181–189. doi: http://dx.doi.org/10.5435/JAAOS-D-13-00148.

Kekelekis, A. *et al.* (2020) 'Risk factors for upper limb injury in tennis players: A systematic review', *International Journal of Environmental Research and Public Health*, 17(8). doi: 10.3390/ijerph17082744.

Kemenkes (2013) *Pedoman gizi olahraga prestasi*. Jakarta: Bina Gizi dan KIA.

Kurdanti, W. *et al.* (2015) 'Faktor-faktor yang mempengaruhi kejadian obesitas pada remaja', *Jurnal Gizi Klinik Indonesia*, 11(4), p. 179. doi: 10.22146/ijcn.22900.

Kusnandar, K. *et al.* (2020) 'Bola Voli : Bagaimanakah Kondisi Index Massa Tubuh Atlet?', *Sporta Saintika*, 5(2), pp. 95–106. doi: 10.24036/sporta.v5i2.134.

Maheshwari, A. *et al.* (2022) 'Electromyographical Analysis of Table Tennis Forehand Stroke Using Different Ball Materials', *Physical Education Theory and Methodology*, 22(2), pp. 249–254. doi: 10.17309/tmfv.2022.2.15.

Marques, V. B. *et al.* (2017) 'The Functional Movement Screen (Fmstm) In Elite Young Soccer Players Between 14 And 20 Years: Composite Score, Individual-Test Scores And Asymmetries. ', *International Journal of Sports Physical Therapy*, 12(6), pp. 977–985. doi: https://doi.org/10.26603/ijspt20170977.

Meffert, D. *et al.* (2021) 'Towards an understanding of big points in tennis: Perspectives of coaches, professional players, and junior players', *Journal of Physical Education and Sport*, 21(2), pp. 728–735. doi: 10.7752/jpes.2021.02090.

Monteiro, A. M. *et al.* (2019) 'The effects of daily physical activity on functional fitness, isokinetic strength and body composition in elderly community-dwelling women', *Journal of Human Sport and Exercise*, 14(2), pp. 385–398. doi: 10.14198/jhse.2019.142.11.

Nufus, S. . (2015) *Aktivitas Fisik, Asupan Lemak dan Persen Lemak Tubuh Pada Remaja Di Kabupaten Dan Kotamadya Bogor*. Institut Pertanian Bogor.

Nurhasan, H. and Cholil, H. D. (2014) *Tes dan Pengukuran Keolahragaan*. Bandung: Universitas Pendidikan Indonesia.

Pontaga, I. and Žīdens, J. (2011) 'Estimation of body mass index in team sports athletes', *Lase Journal of Sport Science*, 2(2), pp. 33–44. Available at: https://www.researchgate.net/publication/260385568_ESTIMATION_OF_BODY_MASS_INDEX_IN_TEAM_SPORTS_ATHLETES.

Purnamasari, D. U., Dardjito, E. and Kusnandar, K. (2015) 'Analisis Status GAKY dan Aspek Kesehatan yang Berhubungan dengan Prestasi Belajar Anak Sekolah Dasar di Daerah Endemis GAKY', *Kesmas Indonesia: Jurnal Ilmiah Kesehatan Masyarakat*, 7(2), pp. 71–81.

Richmond, S. A. *et al.* (2016) 'Examining Measures of Weight as Risk Factors for Sport-Related Injury in Adolescents', *Journal of Sports Medicine*, pp. 1–5. doi: 10.1155/2016/7316947.

S. Dines, Joshua et al. (2015) 'Tennis injuries: Epidemiology, pathophysiology, and treatment', *Journal of the American Academy of Orthopaedic Surgeons*, 23(3), pp.

181–189. doi: doi: 10.5435/JAAOS-D-13-00148.

Sedeaud, A. *et al.* (2014) 'BMI, a performance parameter for speed improvement', *PLoS ONE*, 9(2), pp. 1–7. doi: 10.1371/journal.pone.0090183.

Sonal, K. (2018) 'Effective Conditioning Program for Junior Tennis Players', *Journal of Physical Fitness, Medicine & Treatment in Sports*, 4(1), pp. 1–5. doi: 10.19080/jpfmts.2018.04.555629.

Suhartoyo, T. *et al.* (2019) 'Identifikasi Kebugaran Jasmani Siswa SMP Di Daerah Dataran Tinggi Kabupaten Banyumas', *Physical Activity Journal*. doi: 10.20884/1.paju.2019.1.1.1995.

Syafei, M. *et al.* (2019) *Buku Ajar Tenis Lapangan*. Purwokerto: Unsoed Press.

Syafei, M. *et al.* (2020) 'Functional Movement Screening: An Early Detection of The Student Injury Risk in Sport Class', *Jurnal Pendidikan Jasmani dan Olahraga*, 5(2), pp. 182–191. doi: 10.17509/jpjo.v5i2.25466.

Tengah, R. P. J. (2010) *Laporan Riset Kesehatan Dasar Jawa Tengah*. Semarang.

Widyaningsih, R. *et al.* (2021) 'eSport and Philosophy Behind : A Literature Review', *Annals of Tropical Medicine & Public Health*, 24(3). doi: http://doi.org/10.36295/ASRO.2021.24348.