Analysis of energy systems in Greco-Roman and freestyle wrestlers participated in 2015 and 2016 world championships

Abstract. *Aim:* The aim of this study was analysis of energy systems in Greco-Roman (GR) and freestyle (FS) wrestlers participated in 2015 and 2016 world championships (WCH).

Material and Method: The materials of the present study consisted 801 videos (679 of 2015 WCH and 122 of 2016 WCH) which were posted by United World Wrestling (UWW) on their website also a multimedia player (laptop) for watching the videos and a chronometer to record the durations of wrestling matches. Data were recorded on specially designed sheets which were prepared in advance to record data properly (Table 1). For analyzing the obtained data descriptive (mean and standard deviation) and inferential (Kruskal-Wallis H and Mann-Whitney U) statistics were used. Also, Kolmogorov-Smirnov test at the significantly level of $p<0.05$ was used for normality distribution of data.

Results: The obtained result showed relative contribution of energy systems are 6.4 %, 60.71 % and 32.89 % for ATP-PC (ATP), Lactic Acid (LAC) and aerobic (AERO) energy systems in a wrestling match respectively.

Conclusion: there were some differences between wrestling styles and WCH in respect to relative contribution of energy systems. Besides, we determined the quality and quantity of obtained scores by both GR and FS wrestlers and the result showed FS wrestlers generally catch more scores than GR wrestlers. Additionally, we investigated the placers' competition efficiency which showed top wrestlers who won the gold medalist also had a better competition efficiency than other placers and this difference was statistically significant between them ($p<0.05$).

Keywords: wrestling, obtained scores, competition efficiency, videos, specially designed paper.

Introduction

Since the beginning of time, wrestling has been one of the major physical activity of mankind (7). Moreover, it was one of the few original events in the ancient Olympics (4). Today, wrestlers compete in Greco-Roman (GR) or freestyle (FS) wrestling in all over the world. In GR wrestling, grasping the opponent's lower body is forbidden, as well as leg attacks, or using the legs actively to perform any actions. On the other hand, in FS wrestling, these actions are permitted. These differences in the rules between wrestling styles allow the GR and FS to be viewed as different combat sports (2).

World champions are demonstrating the best quality of wrestling and it is very important for coaches to analyze the technical-tactical structure and the efficiency of the winners to compare their athletes with top athletes (9). Furthermore, understanding the physical and physiological factors contributing to successful wrestling is one of the challenges that coaches and wrestlers confront with (7). Of note, periodic changes in wrestling rules by united world wrestling (UWW) which almost usually happen after each Olympic Games may also influence the methods of training used by successful wrestlers (4), because of these changes the profile of wrestlers in previous studies my not be relevant today (7). For instance, a number of wrestling regulations have been modified after 2012 and 2016 Olympic games by the UWW. Particularly, the structure of a match is now two 3-min periods rather than three 2-min periods and Judging criteria have been modified as well. These changes have altered the physiological challenges to the various energy-delivery systems (7) and have wrestlers to choose an attack oriented strategy and be more aggressive in matches because there are some penalties for defensive ones (8).

A wrestling match is an alternative physical activity of variable intensity. It is characterized by sudden, explosive attacks and counterattacks which repeatedly

executed during a wrestling match. In wrestling, as in many other sports, energy systems (anaerobic and aerobic) are employed to a various degree (5). The anaerobic system provides quick bursts of maximal power during the match, while the aerobic system contributes to the wrestler's ability to maintain effort for the duration of the match and to recover between periods (8). Also, the interaction and relative contribution of the 3 energy systems (anaerobic (alactic and lactic) and aerobic) during periods of maximal exhaustive exercise, like a wrestling match, is of considerable theoretical and practical interest since 1960s and 1970s (3).

However, dynamic nature and unpredictable situations which wrestlers are engaged in, and the energy demands of the situations, such as offense and defense positions, make the designing of wrestling program hard for trainers and coaches. For this reason, estimating the energy demands in elite wrestlers can help wrestlers and their trainers for planning well-designed programs.

As Gastin (2001) mentioned the relative contribution of three energy systems dependent on the intensity, duration and mode of exercise, because of this reason we considered it is possible to estimate the relative contribution of three energy system with recording the light, moderate and vigorous durations of wrestling matches by using world championships (WCH) recorded videos. Therefore, the purpose of this study was to analysis of energy systems in Greco-Roman and freestyle wrestlers participated in 2015 and 2016 world championships.

Material and Method

The research material included all videos of 2015 and 2016 WCH (non-Olympic weights; 61 and 70 kg in FS, 71 and 80 kg in GR) which were posted by the UWW on their website, a multimedia player to watch and analyze the videos and a chronometer to measure the different durations (light, moderate and vigorous) of matches. The material consisted 801 videos (679 videos of

2015 WCH and 122 videos of 2016 WHC) in different weight classes of GR and FS wrestling. According to the objectives of this research each video analyzed two times and obtained data recorded on specially designed sheets which were prepared in advance to record data properly (Table 1). These sheets included data on weight classes, whole duration of match, legal time (two 3-min), quick and explosive movements, duration of vigorous activities, efficiency of competitors (placers) and, the quality and quantity of obtained scores (1, 2, 4 or 5-point).

Statistical analysis

For description and explanation of obtained data researchers used descriptive statistics (mean and standard deviation) in form of tables and graphs, and inferential statistics (Kruskal-Wallis H and Mann-Whitney U ($p<0.05$)) to check the differences between wrestling styles, championships and placers. Also, Kolmogorov-Smirnov test was used for normality distribution of data. Excel and SPSS (version 22) software were used to draw the graphs and for data analyzing respectively.

Table 1. Specially designed sheets for recording data

weight classes	whole duration of match	legal time	quick and explosive movements	duration of vigorous activities	efficiency of competitors				quality and quantity of obtained scores

In first analysis, we recorded data consist of weight classes (all the weight categories in GR and FS wrestling which determined by UWW), whole duration of match (consisted all durations like legal time (two 3-min), 30-s recovery between periods, injury time-outs and so on), legal time (two 3-min, but it may take less than 6 minutes under four conditions (victory by fall, injury, technical superiority and disqualification)), quick and explosive movements (all the quick and explosive actions such as leg attacks, throws and even a fast movement of hands in order to bash the opponent's balance) and duration of vigorous activities (when wrestlers are in contact and trying to take down their rival). Then, in second analysis we recorded the placers' competition efficiency (placers, GOLD; who won the gold medalist, SILVER; who won the silver medalist, BRONZE 1; who lost to the GOLD and won the bronze medalist and BRONZE 2; who lost to the SILVER and won the bronze medalist), for this purpose we gave +1 for actions which ended in point, 0 for actions that ended no point and -1 for actions which cause loss point, then we calculated the sum of the given numbers as placers' competition efficiency. Finally, the quality and quantity of obtained scores were recorded.

Analysis of energy systems with use of match durations:

ATP-PC energy system (ATP): because of the short and quick nature of explosive movements, we were not able to record the time of these actions accurately with chronometer. So, we decided record all these actions then give 1 second to each of them. Finally, the whole obtained time was counted as ATP.

Lactic Acid energy system (LAC): recorded time for duration of vigorous activities counted for lactic acid energy system. But before this we subtracted the ATP duration from duration of vigorous activities because explosive actions were happened within this time.

Aerobic energy system (AERO): we counted the time of light and moderate activities for this energy system. These activities included the time when wrestlers were not in contact such as 30-sec recovery between periods, recovery between points and, video check and injury times-outs etc. For this purpose, we subtracted the duration of vigorous activities from whole duration of match and counted the obtained time as the time of AERO.

In order to determine the relative contribution of each energy system we calculated the ratio of time of each energy system to the whole duration of match.

Results

The present study showed the average of whole duration and legal time of a wrestling match respectively take 6.94±2.27 and 4.88±1.71 minutes (min). Also, the comparison between FS and GR in 2015 WCH indicated GR matches significantly take longer in whole duration ($p<0.05$) and there were no significant differences between FS and GR in 2016 WCH. In addition, comparison between similar weights of FS in 2015 and 2016 WCH showed no significant differences but significant differences were observed between similar weights of GR which showed 2015 WCH matches took longer in whole duration and shorter in legal time ($p<0.05$).

Figure 1 shows the relative contribution of energy systems in a wrestling match. The obtained result of 2015 WCH showed FS wrestlers significantly used more ATP than GR wrestlers ($p<0.05$). The comparison between FS and GR wrestlers in 2016 WCH indicated FS wrestlers significantly employed less LAC and more AERO than GR wrestlers ($p<0.05$). In addition, when similar weights of 2015 and 2016 WCH were compared separately in each style, obtained result showed no significant differences between FS wrestlers but GR wrestlers in 2015 WCH

significantly employed less anaerobic energy systems (ATP and LAC) and more AERO ($p<0.05$).

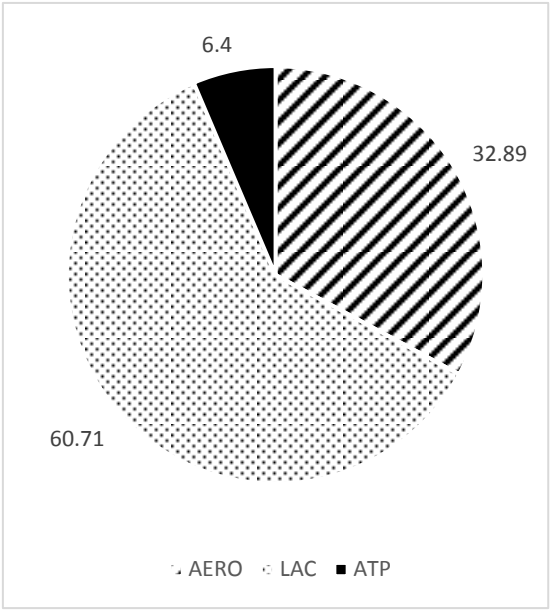

Figure 1. Relative contribution of energy systems in a wrestling match (percent)

In addition, we investigated the quality and quantity of obtained scores (figure 2). The comparison between FS and GR in 2015 WCH showed the quality of 2-point scores was significantly greater in FS ($p<0.05$) also the quantity of 1-point and 2-piont scores was significantly greater in FS ($p<0.05$). In addition, comparison between FS and GR of 2016 WCH showed no significant differences between these styles in quality and quantity of obtained scores. Finally, we compared the similar weights of 2015 and 2016 WCH separately in FS and GR, and obtained result showed no significant differences in mentioned variables.

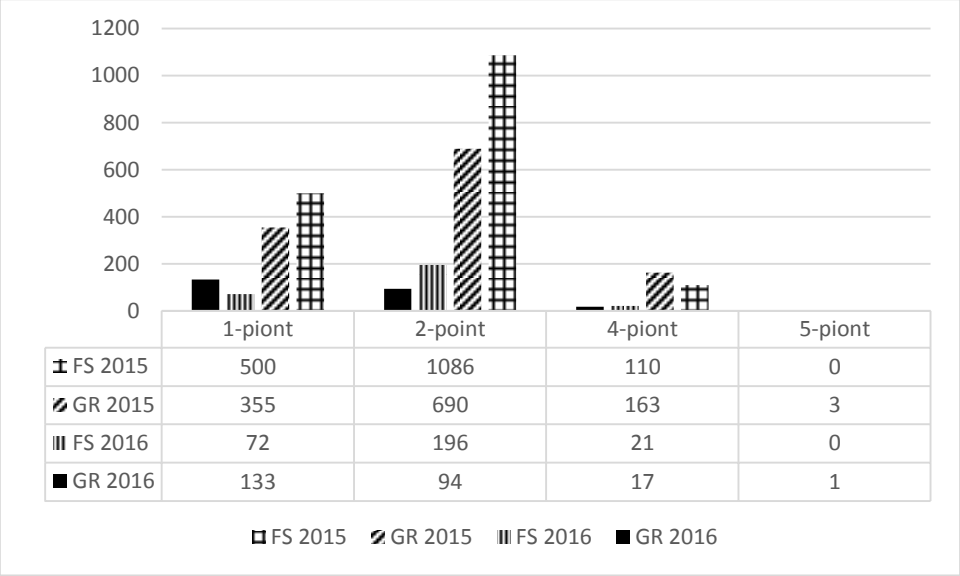

Figure 2. Quantity of obtained scores in 2015 and 2016 WCH

Table 2 shows the competition efficiency of FS and GR placers in 2015 and 2016 WCH. Generally, GOLD had the highest average of competition efficiency but it was not right for all weight categories also the difference between GOLD and other placers was statistically significant ($p<0.05$). The comparison between FS GOLD and other placers in 2015 WCH showed a significant difference between GOLD and SILVER ($p<0.05$). Also, there were significant differences between GR GOLD compare with SILVER and BRONZE 1 in 2015 WCH ($p<0.05$). This study showed no significant differences between FS GOLD compare with other placers in 2016 WCH but the average of GOLD competition efficiency was greater than other placers. The obtained result for GR placers in 2016 WCH showed no significant differences between GOLD and other placers. The GOLD had greater average of competition efficiency than SILVER and BRONZE 1 but less than BRONZE 2.

Table 2. Competition efficiency of placers

	GOLD	SILVER	BRONZE 1	BRONZE 2
FS 2015	17.87±4.70	12.75±2.54*	14.62±8.70	12±5.52
GR 2015	12±3.38	6.12±2.29*	7.5±3.07*	9.37±4.34
FS 2016	17.5±2.12	13.5±0.70	11.5±6.36	12±1.41
GR 2016	6±1.41	3±2.82	2.5±2.12	9.5±0.70
AVERAGE	14.30±5.35	9.20±4.47*	10.25±7.17*	10.70±4.48*

* $p < 0.05$ for significant difference between other placers and GOLD

Discussion

As we already mentioned, the structure of a wrestling match is two 3-min (6 min) periods now but it may take shorter when a wrestler wins a match by fall, injury, technical superiority or disqualification. The present sample indicated the whole duration and the legal time of a wrestling match generally takes less than 7 min (6.94±2.27) and 5 min (4.88±1.71 min) respectively. Furthermore, there was no significant difference between wrestling styles in legal time but statistically significant was observed between FS and GR in whole duration of match which showed GR matches take longer in 2015 WCH. This significant difference can be attributed to different rules of these styles for example, GR wrestlers repeatedly stopped during a match because referees should give passive violation to passive wrestlers also aggressive wrestlers were asked if they wanted to continue the match in stand or ground position, the result of these actions is prolonging a GR match in whole duration. Moreover, this difference between FS and GR did not observed in 2016 WCH and it is obvious that GR rule changes are the reason, because in new instituted rules by UWW after 2016 Olympic games, passive violations will give to passive wrestlers without any stops during a match. In addition, FS wrestlers in 2015

WCH compare with similar weights in 2016 WCH had no significant differences in mentioned variables. In contrast, GR matches in 2015 WCH significantly took longer in whole duration and shorter in legal time compare with similar weights in 2016 WCH. As it mentioned above, rules changes are the reason for these differences.

There is not a universally accepted method with a direct test for its validation to quantify anaerobic energy release, also current methods for quantification anaerobic energy release are less precise. Because of these, the accurate determination of anaerobic energy release during intense whole-body exercise like a wrestling match continue to pose a problem (3). Some researchers such as Horswill (1992) and Mirzaei et al. (2009) declared that wrestling is anaerobic in nature and Ohya et al. (2015) declares both anaerobic and aerobic energy systems are employed to various degree in wrestling but the relative contribution of three energy systems in wrestling were not shown in any investigation.

It has been shown that relative contribution of energy systems depends on duration and intensity of exercise (3) which was the main idea of our investigation. The present sample showed relative contribution of APT, LAC and AERO during a wrestling match were 6.4 %, 60.71 % and 32.89 % respectively. The relative contribution of ATP was less than 10 percent but it has a determinative role during a wrestling match, though. Because, approximately all the scores are the result of explosive and quick actions. Additionally, our result showed the relative contribution of LAC was about 60 percent. According to this, it can be calculated that the nature of wrestling is anaerobic which is in accordance with Horswill (1992) and Mirzaei et al. (2009) investigations. Finally, the relative contribution of AERO was about 30 percent. Of note, we determined the relative contribution of energy systems in a single wrestling match not during a wrestling tournament in which wrestlers have to conduct 4-5 duels before final in about 5 hours (6). Also, rest interval between third and forth, forth and fifth fights may be only 15-20 minutes (6), in these conditions an ideal aerobic fitness is critical for wrestlers to help them recover their body.

In the present study, FS wrestlers significantly used ATP more than GR wrestlers in 2015 WCH. As mentioned above, obtained scores are the result of explosive actions (ATP) and the present sample showed FS had significantly greater quality in 2-point scores and quantity in 1-point and 2-point scores which are the reasons to calculate FS is more dynamic and wrestlers in this style usually choose an attack oriented strategy.

The obtained result for 2016 WCH showed FS wrestlers used less LAC and more AERO than GR wrestlers. Moreover, the analysis of obtained scores showed no significant difference but figure 2 shows FS wrestlers had a greater quantity of 2-point and 4-point scores, because of this, they had more interval rest between scores and were less in contact (we accounted the time when wrestlers were in contact as the time of LAC) so the result is employing less LAC and more AERO than GR wrestlers. Also, using more LAC by GR wrestlers and obtain less scores show after execution the new rules in GR, wrestlers try more in stand position but they catch less scores. In addition, lots of 1-point scores in GR are the result of passive violations not the technical executions also some matches, even some of the finals ended in no technical point in 2016 WCH which shows new rules should review and modify by UWW.

No significant differences were observed in similar weights of FS in using of energy system and, quality and quantity of obtained scores between 2015 and 2016 WCH. In contrast, Significant differences were observed in similar weights of GR in using of energy systems between 2015 and 2016 WCH. More analysis indicated GR wrestlers in 2016 WCH have used more LAC and less AERO, and we already discussed that the reason is rule changes. Also, there were no significant differences between similar weights of GR in obtained scores between 2015 and 2016 WCH.

It should be mentioned that the result of 2015 WCH were obtained of all the weight categories of FS and GR while the result of 2016 WCH were obtained of just two weight categories in each style (61 and 70 kg of FS; 71 and 80 kg of GR). So, the obtained result of 2016 WCH may be less precise that obtained result of 2015 WCH.

The result of this research indicated GOLD generally had a better competition efficiency rather than other placers and the average of GOLD competition efficiency was statistically significant compare with other placers in both GR and FS. This greater competition efficiency absolutely is a great advantage for GOLD and could be an important reason for their better result. As it showed in table 2, FS wrestlers had greater competition efficiency than GR. This difference can be attributed to greater complexity of FS because in FS all techniques that include using arms and legs actively are allowed (1).

Conclusion

The present sample indicated the whole duration and the legal time of a wrestling match generally takes less than 7 min (6.94±2.27) and 5 min (4.88±1.71 min) respectively. Also, LAC has the most contribution in energy release during a single wrestling match which represents the anaerobic nature of wrestling. Additionally, our result showed the nature of FS is more dynamic than GR because FS wrestlers can use all the GR techniques, as well as leg attacks by using arms and legs actively. All in all, GOLD had the greatest competition efficiency compare with other placers in both styles of wrestling.

The result of this study has obtained by using the recorded videos of the latest world championships which were conducted by the last changes in wrestling rules. Also, participated wrestlers in these championships were the best in the world. Of note, we analyzed and compared wrestling matches and placers by using the same method. We hope the result of the present study help wrestlers and coaches to design their training programs better, as well as choose a better strategy in their matches.

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