ARE THERE CONNECTIONS BETWEEN THE BODY FAT PERCENTAGE, COMPETITIVE RESULTS AND MOTIVATION IN WHEEL GYMNASTS?

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Abstract
Motivation is a performance-limiting factor in sports. Thus, the relevance of motivation for performance in wheel gymnastics must be clarified. 203 German gymnasts were studied. Motivational differences were found between different disciplines and performance levels. Differences between performance levels were also present in groups grouped by discipline. Additionally, a connection was found between hope for success and body fat percentage as well as motivational factors and deductions to difficulty score. Several motivational aspects correlated with age. There were significant correlations between motivational factors and age at different performance levels. Results suggest that motivation might be relevant for the development of talent in wheel gymnastics

Keys words: wheel gymnastics, body fat percentage, judges, competitive results, motivation.

INTRODUCTION

Wheel gymnastics originated in Germany in 1925 when Otto Feick built a two-rimmed wheel in which a person can stand while the wheel itself is moving (Sebesta, 2002). In current wheel gymnastics, there are four different disciplines: vault, straight line with/ without music, spiral, and, more recently, cyr (Kauther, Rummel, Hussmann, Lendemans, Wedemeyer & Jaeger, 2015). In wheel gymnastics, points are given to the athlete for technical difficulty and composition of a routine but deducted from the execution value if the athlete performs a movement technically correctly but inaccurately (Deutscher Turner-Bund (DTB), 2008). According to literature, the disciplines demand strength, endurance, flexibility, as well as core, explosive and jumping strength, coordination of movement, concentration, emotional control, perception, stress resistance and self-esteem, as well as aesthetic expression (Hundrieser, 2012; Weyermann, 2016).

Sports performance is limited by physical aspects and psychological factors such as motivation: psychological factors in performance have, for example, been researched in volleyball (Mostafa & Mansour, 2016), netball (Grobbelaar & Eloff, 2011) and soccer (Hughes, Caudrelier, James, Redwood-Brown, Donnelly, Kirkbride et al., 2012). It should be researched whether motivation is also relevant to performance in wheel gymnastics. Hume, Hopkins, Robinson, Robinson & Hollings (1993) found that motivation correlates with attainment in gymnastics, while D'Arripe-Longueville, Hars, Debois & Calmels (2009, p.424)

showed that "the main psychological characteristics developed by all the participants pertained to achievement motivation, performance enhancement cognitive skills (e.g., focusing, imagery), and affective and psychosomatic skills (e.g., ability to deal with anxiety; relaxation)". It is claimed that a strong motivational driving force is essential to perform high level gymnastic exercises and maintain daily practice (Munkácsi, Kalmár, Hamar, Katona & Dancs, 2012).

When selecting gymnasts for wheel gymnastics, the current discussion regarding talent selection must be kept in mind. Samuelsen (2003) claims that anthropometric factors are irrelevant for performance in wheel gymnastics because the wheels come in different sizes. Rummel (2016), however, names BMI as relevant for wheel gymnastics and claims that it is comparable to that in ski-jumping (Muller, Groschl, Muller & Sudi, 2006). Female gymnasts show a lower BMI than males and female wheel gymnasts have the lowest percentage of body fat in the German population (Kromeyer-Hauschild, Wabitsch, Kunze, Geller, Geiß, Hesse et al, 2001). Some gymnasts' BMI is below the z-scores recommended by the World Health Organization (Onis, Onyango, Borghi, Syiam, Nishida & Siekmann, 2007). According to Rummel (2016), low BMI is mostly prevalent in amateur wheel gymnasts. Findlay & Ste-Marie (2004) state that in figure skating, expectations of judges can be reflected in the ratings. According to the authors, judges might, for example, associate low body fat percentage with a higher motivation for extensive practice and discipline and award marks accordingly, thus judging not the performance but the psychological characteristics supposedly displayed by the physical appearance of the gymnasts.

However, fitness and physical factors are viewed with reservations in talent selection (Gonçalves, Rama & Figueiredo, 2012); therefore, mental skills might be of better use (Baron-Thiene & Alfermann, 2015). According to Moesch, Hauge, Wikman & Elbe (2013), skills such as volition and probably motivation might be a better predictor than other performance factors in selecting for team sports. This might also be true for individual sports and thus for wheel gymnastics. However, only a few studies so far have researched the connection between motivation and performance in gymnastics and no studies in wheel gymnastics in particular. Koumpoula, Tsopani, Flessas and Chairopoulou (2011) found high motivation in rhythmic gymnasts. Additionally, motivation and training time can be seen as predictors of attainment in gymnastics (Hume, Hopkins, Robinson, Robinson & Hollings, 1993). In team handball, differences were found between male and female athletes (Kristjánsdóttir, Erlingsdóttir, Sveinsson & Saavedra, 2018).

Mies (1994) states that wheel gymnastics can be considered an aesthetic sport, where athletes are required to look slim (Potter, Lavery & Bell, 1996). In aesthetic sports, such as artistic and rhythmic gymnastics, performance is related to thinness (Avilla-Carvalho, Klentrou, Luz Palomero & Lebre, 2013; Falls & Humphrey, 2013; Bacciotti, Baxter-Jones, Gaya & Maia, 2017, amongst others). Athletes in aesthetic sports display lower body fat values than non-athletes or athletes from other sports (Georgopoulos, Markou, Theodoropoulou, Bernadot, Leglise & Vagenakis, 2002; Gomez-Landero, Vernetta & Bedoya, 2009; Parm, Saar, Pärna, Jürimäe, Maasalu, Neissaar & Jürimäae, 2011; Galetta, Franzoni, D'Alessandro, Piazza, Tocchini, Fallahi et al., 2015; San Mauro Martín, Cevallos, Pina Ordúñez & Garicano Vilar, 2016). Compared to other aesthetic sports, wheel gymnasts display a rather low percentage of body fat and earn lower scores from the judges for their performance (Weber, 2020). Thinness might be related to motivation.

These findings further suggest that an overrating of the aesthetic aspect of athletes could endanger the healthy development and motivation of young competitors and thus lead to an early drop-out. If overrating of aesthetic aspects takes place in wheel gymnastics, gymnasts and especially young gymnasts, should be protected. At the same time, psychological factors may be a better predictor of future success than physical aspects; therefore, selection and mental training should take place according to the actual motivational performance demands.

Therefore, this study aims to answer the following questions:

1. Are there significant differences in motivation between:

a) gymnasts at different performance levels;

b) female and male wheel gymnasts; and

c) gymnasts competing in different disciplines?

2. Is there a connection between motivation and performance during

a) training, and

b) competition

regarding overall merit, difficulty, composition, and execution?

3. Is there a connection between percentage of body fat and motivation?

4. Is there a connection between motivation and the difference between the planned and earned difficulty score?

5. Does motivation correlate with age?

METHODS

Measurements included 203 voluntary participants (female: N = 183, % body fat average = 14.54 ± 3.4 and age average = 21.17 ± 11.91; male: N = 20, % body fat average = 8.00 ± 3.74 and age average = 16.84 ± 4.90) of the German Gymnastics Federation (Deutscher Turner-Bund/ DTB), section gym-wheel. The age ranged from 6 to 58 for female and from 7 to 27 for male gymnasts. Only gymnasts participating in a competition on the day of measurement were included. Informed consent was obtained from all participants.

Skin folds were recorded using a calliper (Slim Guide, Creative Health Products, Plymouth, Michigan). Competitive results, performance during training, evaluation of the current competition, gender, age and competitive level were obtained using a specially developed questionnaire. All values were recorded at major national competitions in 2018.

Body fat percentage was calculated using the method of Siri (1956) for calculating body fat, using three skin folds for female gymnasts (Jackson, Pollock & Ward, 1980). For male gymnasts, Siri (1956) and Jackson & Pollock (1978) were used to calculate the percentage of body fat using three skin folds and two circumferences. Due to different compositions of body tissue, female and male athletes require individual calculation methods (Jackson & Pollock, 1978; Jackson et al., 1980).

Percentage of body fat was calculated with $\%\_Bodyfat = (4.95 / Body\ density) - 4.5$ (Siri, 1956). Body density was calculated with $Body\ density = 1.096095 – 0.0006952 * sf\_tri + sf\_abd + sf\_sup + sf\_thigh) + 0.0000011 * (sf\_tri + sf\_abd + sf\_sup + sf\_thigh)^2 – 0.0000714 * age$ for female gymnasts (Jackson, Pollock & Ward, 1980), using age in years and four skinfolds, where sf = skinfold, tri = triceps, abd = abdominal, sup = suprailiacal and thigh = directly above the knee. Body density for male gymnasts was calculated with $Body\ density = 1.15737 – 0.02288 * ln(sf\_pect + sf\_abd + sf\_thigh) – 0.00019 * age – 0.0075 * c\_nav + 0.223 * c\_arm$ (Jackson & Pollock, 1978), using age in years, two skinfolds and two circumferences, where sf = skinfold, pect = pectoralis, abd = abdominal, c_nav = circumference at navel height and c_ arm = highest circumference of the lower arm.

Motivation was measured using the Achievement Motives Scale (AMS) by Elbe & Wenhold (2005), which consists of the following dimensions: hope of success; fear of failure; net hope (hope of success minus fear of failure), and total achievement motive (sum of hope of success and fear of failure). The questionnaire is in use in German talent selection in team sports up to the national level (Beckmann & Linz, 2009) and suitable for talent selection in several sports (Wenhold, Meier, Beckmann, Elbe & Ehrlenspiel, 2007). The scale consists of 30 questions with 0 to 3 points per question; there are 15 questions for hope of success (0 to 45 points) and 15 for fear of failure (0 to 45 points); on this basis, net hope is calculated as net hope = hope of success – fear of failure (-45 to 45 points) and the total achievement motive as total achievement motive = hope of success + fear of failure.

An additional questionnaire asked for age, gender, straight line difficulty (technical merit) achieved during training and straight line difficulty achieved at the last competition. The difficulty difference was calculated as the difference between the technical difficulty achieved during training minus the technical difficulty achieved during competition in the straight line discipline. In German competitive wheel gymnastics, gymnasts are required to hand in a difficulty chart before competition, stating what difficulty they were able to perform during training and therefore intend to perform in competition.

Oneway ANOVA was used to compare gymnasts at both performance levels (Bundesklasse/ Landesklasse) and within two disciplines (Straight line/ All-around), once for all gymnasts and once for female gymnasts only, as there was an insufficient number of male participants. The criterion level for significance was set at $p<0.05$ and the trend significance at $p<0.10$. Effect size was evaluated with η^2 (Eta partial squared), where $0.01<\eta^2<0.06$ constitutes a small effect, $0.06<\eta^2<0.14$ constitutes a medium effect and $\eta^2>0.14$ constitutes a large effect (Cohen, 1988). Correlations between performance and motivation were calculated via Pearson and Spearman`s Rho with correlation levels >0.1 (weak), >0.3 (moderate) and >0.5 (strong). Different types of correlation coefficients were used due to varying sample sizes as well as outliers and lack of homogeneity within subgroups (Malawi-Paper, David 1938). Statistical analysis was carried out in SPSS, version 25 (SPSS, Inc., Chicago, IL).

RESULTS

While no difference in motivation was found between female and male gymnasts, significant differences occurred between gymnasts competing in different disciplines (Table 1) and at different performance levels (Table 2). Differences between performance levels were also present when gymnasts were grouped according to discipline (Table 2).

Table 1
Differences in motivation between gymnasts competing in different disciplines at different performance levels (due to the small number of participants, male gymnasts were not considered separately).

Differences	N	$\bar{X} \pm SD$	p	η^2
Both genders				
Straight line vs. all-around				
	80 vs. 42			
Hope for success	78 vs. 42	*33.43 ± 7.54 vs. 36.81 ± 4.90*	*0.010*	*0.055*
Overall performance motive		43.95 ± 9.27 vs. 47.57 ± 8.90	0.039	0.036
BK*, straight line vs. all-around				
Hope for success	6 vs. 30	41.33 ± 4.80 vs. 36.93 ± 4.81	0.049	0.110
Fear of failure	6 vs. 30	4.50 ± 4.93 vs. 11.83 ± 8.82	0.058	0.101
Net hope	6 vs. 30	36.63 ± 9.63 vs. 27.06 ± 11.53	0.021	0.148
LK**, straight line vs. All-around				
Net hope				
	46 vs. 7	22.43 ± 11.31 vs. 30.43 ± 11.27	0.087	0.086
Female gymnasts				
Straight line vs. All-around				
Hope for success	*73 vs. 35*	*33.56 ± 7.86 vs. 36.91 ± 5.20*	*0.021*	*0.049*
Overall performance motive	72 vs. 35	43.56 ± 9.03 vs. 47.63 ± 9.42	0.033	0.042
BK*, straight line vs. All-around				
Hope for success	6 vs. 25	41.33 ± 4.80 vs. 37.08 ± 5.16	0.077	0.104
Fear of failure	6 vs. 25	4.50 ± 4.93 vs. 11.88 ± 9.55	0.079	0-102
Net hope	6 vs. 25	36.83 ± 9.62 vs. 25.02 ± 11.87	0.034	0.146
LK**, straight line vs. All-around				
Net hope				
	41 vs. 6	22.76 ± 11.54 vs. 31.67 ± 11.81	0.085	0.065

No homogeneity of variance *BK = Bundesklasse **LK = Landesklasse

Table 2
Differences in motivation and body fat percentage between gymnasts competing at different performance levels (due to the small number of participants, male gymnasts were not considered separately).

Differences	N	$\bar{X} \pm SD$	p	η^2
Both genders				
BK* vs. LK**				
Hope for success	*37 vs. 57*	*37.51 ± 5.04 vs. 32.95 ± 7.09*	*0.001*	*0.111*
Overall performance motive	37 vs. 55	47.92 ± 8.48 vs. 42.89 ± 9.81	0.013	0.067
Straight line, BK* vs. LK**				
Hope for success	6 vs. 48	41.33 ± 4.80 vs. 42.60 ± 7.21	0.060	0.137
Fear of failure	6 vs. 46	4.50 ± 4.93 vs. 10.41 ± 7.95	0.083	0.059
Net hope	6 vs. 46	36.83 ± 9.62 vs. 22.43 ± 11.31	0.005	0.150
Female gymnasts				
BK* vs. LK**				
Hope for success	32 vs. 50	37.19 ± 5.32 vs. 33.02 ± 7.23	0.002	0.111
Overall performance motive	32 vs. 49	47.94 ± 9.00 vs. 42.51 ± 9.82	0.014	0.074
Straight line, BK* vs. LK**				
Hope for success	6 vs. 42	41.33 ± 4.80 vs. 32.67 ± 7.31	0.007	0.146
Net hope	6 vs. 41	36.83 ± 9.62 vs. 22.76 ± 11.54	0.040	0.152
Body fat percentage	7 vs. 42	12.27 ± 3.24 vs. 15.54 ± 3.86	0.007	0.087
All-around, BK* vs. LK**				
Body fat percentage	26 vs. 6	12.78 ± 2.52 vs. 17.14 ± 3.52	0.001	0.296

No homogeneity of variance *BK = Bundesklasse **LK = Landesklasse

Table 3

Correlations between motivation, performance factors, body fat percentage and difference between planned and earned difficulty score.

		All female gymnasts				Female gymnasts Bundesklasse			
		Hope for success	Fear of failure	Net hope	Overall performance motive	Hope for success	Fear of failure	Net hope	Overall performance motive
Body fat percentage	*r*	-0.201	0.078	-0.136	-0.013	-0.220	0.141	-0.204	0.014
	p	0.036	0.420	0.162	0.895	0.227	0.442	0.262	0.938
	N	109	108	108	108	32	32	32	32
Difficulty (competition)	*r*	0.086	0.211	-0.054	0.265	-0.327	0.044	-0.170	-0.141
(Straight line)	*p*	0.420	0.046	0.616	0.012	0.128	0.843	0.438	0.522
	N	91	90	90	90	23	23	23	23
Difficulty (competition)	*r*	0.050	-0.117	0.179	-0.075	0.050	-0.456	0.396	-0.409
(Vault)	*p*	0.803	0.561	0.371	0.708	0.820	0.029	0.062	0.053
	N	27	27	27	27	23	23	23	23
Difficulty (competition)	*r*	0.267	0.232	0.069	0.392	0.072	-0.040	0.066	0.008
(Spiral)	*p*	0.153	0.217	0.718	0.032	0.739	0.854	0.760	0.970
	N	30	30	30	30	24	24	24	24
Execution (competition)	*r*	0.062	-0.169	0.160	-0.009	0.058	-0.579	0.470	-0.577
(Straight line)	*p*	0.580	0.131	0.155	0.935	0.792	0.004	0.024	0.004
	N	82	81	81	81	23	23	23	23
Execution (competition)	*r*	-0.181	0.258	-0.314	0.173	-0.206	0.443	-0.454	0.315
(Vault)	*p*	0.367	0.194	0.111	0.388	0.346	0.034	0.030	0.143
	N	27	27	27	27	23	23	23	23
Execution (competition)	*r*	-0.243	-0.047	-0.102	-0.225	-0.369	-0.073	-0.133	-0.309
(Spiral)	*p*	0.222	0.816	0.612	0.260	0.083	0.739	0.545	0.151
	N	27	27	27	27	23	23	23	23
Composition (competition)	*r*	0.043	0.255	-0.124	0.228	-0.155	0.243	-0.251	0.168
(Straight line)	*p*	0.704	0.023	0.277	0.043	0.481	0.264	0.247	0.445
	N	80	79	79	79	23	23	23	23
Difficulty difference	*r*	0.005	0.083	-0.090	0.012	0.005	0.592	-0.457	0.639
(Straight line)	*p*	0.965	0.481	0.444	0.917	0.982	0.005	0.037	0.002
	N	75	74	74	74	21	21	21	21
Difficulty difference	*r*	-0.157	0.312	-0.342	-0.028	0.071	0.425	-0.312	0.455
(Vault)	*p*	0.464	0.138	0.102	0.895	0.759	0.055	0.169	0.038
	N	24	24	24	24	21	21	21	21
Difficulty difference	*r*	0.555	-0.306	0.496	0.148	0.609	-0.312	0.535	0.101
(Spiral)	*p*	0.005	0.146	0.014	0.491	0.004	0.181	0.015	0.673
	N	24	24	24	24	20	20	20	20
Overall merit (training)	*r*	0.089	0.126	-0.004	0.231	-0.194	-0.141	0.027	-0.259
(Straight line)	*p*	0.394	0.229	0.969	0.026	0.375	0.522	0.902	0.232
	N	94	93	93	93	23	23	23	23
DDifficulty (training)	*r*	0.055	0.203	-0.095	0.225	-0.304	0.507	-0.449	0.094
(Straight line)	*p*	0.633	0.078	0.416	0.051	0.169	0.016	0.036	0.678
	N	77	76	76	76	22	22	22	22

Blue = strong correlation, pink = moderate correlation, orange = low correlation; yellow = significant, green = trend.

Table 4
Correlation between motivation and age.

		All female gymnasts	Female gymnasts Landesklasse	Female gymnasts Bundesklasse	All male gymnasts
Hope for success	*r*	-0,188	-0,003	-0,421	0,774
	p	0,048	0,983	0,016	0,002
	N	111	49	32	13
Fear of failure	*r*	-0,054	-0,263	0,415	-0,296
	p	0,574	0,071	0,018	0,350
	N	110	48	32	12
Net hope	*r*	-0,072	0,164	-0,508	0,596
	p	0,454	0,266	0,003	0,041
	N	110	48	32	12
Overall performance motive	*r*	-0,185	-0,154	0,090	0,297
	p	0,052	0,296	0,625	0,348
	N	110	48	32	12

Connections were found between motivation and several performance factors (Table 3). Also, a connection was found between hope for success and body fat percentage (Table 3) as well as motivational factors and difference between planned and earned difficulty score (Table 3). Several motivational aspects correlated with age in both female and male gymnasts at different performance levels (Table 4).

When considering gymnasts at different performance levels, it is evident that when looking at both genders together, gymnasts need to display higher hopes for success and overall performance motive regardless of the discipline, if they want to perform at the Bundesklasse level. When considering only the straight line discipline, however, gymnasts in Landesklasse show higher hope for success. This could be due to the fact that gymnasts in Landesklasse predominantly perform in the straight line discipline and feel more confident than high-level gymnasts who very often perform in the all-around and have to prepare for several disciplines. A lower fear of failure and higher net hope is required for gymnasts of both genders in Bundesklasse. Most probably this helps them to get in a positive mental state prior to competition. For female gymnasts only, the difference between hope for success in Bundesklasse and Landesklasse in straight line is even greater, perhaps due to more intense competition. Other results do not vary much when male gymnasts are eliminated from the calculations.

Significant differences in motivation (hope for success, overall performance motive, see Table 3) were found in gymnasts of both genders, regardless of the performance level, who performed in straight line and all-around. Higher motivation seems to be required for gymnasts who compete in all-around. This might be due to the longer training period and higher intensity (training three disciplines in one session, no breaks) required when training three disciplines instead of only one. When considering female gymnasts at the Bundesklasse level, however, different motivational demands are demonstrated: higher hopes for success and overall performance motive together with a lower fear of failure are necessary when competing only in straight line. This

might be due to the fact that most gymnasts in Germany start their training in the straight line discipline; hence, this discipline has the highest level of competition and the highest difficulties are very frequently achieved. At the Landesklasse level, higher net hope is necessary for gymnasts who compete in the all-around. The all-around discipline has only recently been introduced at the Landesklasse level. Thus, gymnasts need to be very confident to even enter the competition, mostly competing only against small numbers of competitors in the all-around at their performance level. When considering female gymnasts only, the results are almost the same, as there were only a few male gymnasts participating in the study.

When considering the connection between motivation and performance during training, a correlation between the overall performance motive and the overall merit in straight line was found for all gymnasts. Most probably, high motivation is needed to maintain the drive to perform well during training at this level, even if there is no competitive pressure during training. Further, the difficulty value during training in straight line showed a tendency towards correlation with fear of failure and the overall performance motive. This suggests that a certain degree of avoidance of negative stimuli together with pressure created through high difficulty might be necessary to perform well when training for the straight line discipline for gymnasts at all levels. For gymnasts competing at the Bundesklasse level, there was also a positive correlation between fear of failure and difficulty during training in straight line. Further, gymnasts at this level showed a negative correlation between net hope and difficulty during training; this suggests an even stronger connection between negative motivational aspects and performance at this competitive level. Perhaps gymnasts want to secure high difficulty scores to compensate for a potentially flawed execution value.

There are connections between motivation and performance during competition in relation to the difficulty value in straight line and fear or failure as well as overall performance motive when considering gymnasts at all performance levels together. Also, gymnasts at all levels showed a correlation between the difficulty in the spiral discipline during competition and the overall performance motive. Perhaps high difficulty poses a challenge for gymnasts. It is still unusual for an athlete to compete in the spiral discipline at the Landesklasse level, therefore high motivation is probably required to do so. Also, there are positive correlations between the composition merit of the routine and fear of failure as well as overall performance motive. This could be an indication that gymnasts are trying to create a safety net, i.e., using the composition merit to prevent failure in competition. When considering the Bundesklasse gymnasts alone, a negative correlation can be observed between the difficulty in competition in the vault discipline and fear of failure. Additionally, there is a tendency for correlation between competitive difficulty in this discipline and net hope and for a negative correlation with the overall performance motive. This suggests that gymnasts need to have low fear of failure and, conversely, high-self confidence to be able to cope with the prospect of having to perform a high difficulty routine during competition. For the Bundesklasse gymnasts competing in straight line, there is a negative correlation between fear of failure as well as overall performance motive and execution value, along with a positive correlation with net hope, which suggests that fear of failure negatively influences accuracy of movement while high net hope is beneficial. When assessing correlations in Bundesklasse for the execution value during competition in the vault discipline, it is evident that high fear of failure and

low net hope is relevant to achieving high merit, which suggests avoidance motivated behaviour. When looking at the spiral discipline during competition, gymnasts in Bundesklasse show tendency towards displaying lower execution value when their hopes for success are higher. This could mean that gymnasts at this performance level tend to get careless when they are not challenged enough by a task.

When considering the difference between the planned and the achieved difficulty score, several correlations can be observed. The difficulty difference in spiral correlated with hope for success and net hope for all female gymnasts. This could mean that gymnasts might be overestimating their skill when they have high hopes for success, which may lead them to compose their routines with too high difficulty. At the Bundesklasse level, this connection is even more striking. In straight line, gymnasts at the Bundesklasse level showed positive correlations between the difficulty difference and hope for success as well as overall performance motive, but a negative correlation between the difficulty difference and net hope. This suggests that gymnasts suffer a kind of black-out and therefore underperform under pressure due to high fear of failure. A tendency towards the same mechanism can be seen for the vault discipline at the Bundesklasse level.

Although according to Findlay and Ste-Marie (2004) judges might expect this connection, motivational aspects did neither correlate with the body fat percentage nor any performance factors in Landesklasse. This leads to the conclusion that for Landesklasse, neither gymnasts' body fat percentage nor competitive or training performance are influenced by motivational aspects or vice versa. However, when considering all female gymnasts, hope for success correlated negatively with the body fat percentage. In both straight line and all-around, the body fat percentage of female gymnasts is lower in Bundesklasse than in Landesklasse. This is in line with the findings of Weber (2020) and indicates that gymnasts with a higher body fat percentage do not expect to receive good marks from the judges, regardless of the performance level. When considering Bundesklasse only, no correlations could be found between motivational factors and the body fat percentage. It should be noted that for female gymnasts the standard deviation for body fat percentage at the Bundesklasse level was only 3.24 in straight line and 2.52 in all-around compared to 3.86 and 3.52 in Landesklasse. Bundesklasse therefore displays a higher homogeneity for this factor, which means that correlations are not strong enough to be relevant to Bundesklasse alone.

Age correlated with all motivational factors except overall performance motive in Bundesklasse. Age only showed a tendency for correlation with fear of failure in Landesklasse. Female gymnasts at all levels not only showed a negative correlation between age and hope for success, but also a tendency towards negative correlation between age and overall performance motive, probably due fewer performances at higher age.

When comparing the current findings to results from other sports, it is evident that, as in the study of Wolko et al. (1993), wheel gymnasts could benefit from training self-regulation - and this could be of benefit to gymnasts from other disciplines as well. Additionally, achievement motivation and the ability to deal with anxiety seems to be as relevant in wheel gymnastics as in other types of gymnastics (D'Arripe-Longueville et al., 2009). Strong motivation is necessary to perform wheel gymnastics at a high level, which also applies to other gymnastic disciplines, especially when considering the ability to keep motivation up during training (Munkácsi et al., 2012). Motivation (and thus training time) can be seen as predictors of attainment in wheel gymnastics, which is in line with the

findings of Hume et al. (1993) for other gymnastic disciplines.

The small number of participants in general and especially the small number of male participants have to be considered the main limitation of the study. Additionally, it is necessary to repeat the study internationally. The current findings can only be applied to German wheel gymnasts.

CONCLUSION

In summary, motivation has shown to be a performance limiting factor in wheel gymnastics in several ways. It can be concluded that motivation in wheel gymnastics is related to performance, as is in other gymnastic disciplines as shown by Munkácsi et al. (2012). Coaching and mental training and perhaps talent selection should be based on an approach that is tailored individually according to discipline, physical fitness, age and performance level.

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