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MORPHOLOGICAL DIFFERENCES AND PAIN STATUS MONITORING IN DANCE TRAINING

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Abstract. *The purpose of the present research was to identify the possible influence of some of the morphological characteristics on the Self - Estimate Functional Inability because of Pain SEFIP score through detecting the morphological differences of 13±1 (N=27) year old girls and boys, beginners in standard dances. SEFIP was measured after 10 lessons of an intensive standard dance training program. The morphological variables were measured at the beginning of the study and included body weight, height, body mass index (BMI); triceps skinfold, calf circumference, knee diameter and foot length. We analyzed (1) the differences between the boys and girls in all variables, (2) post- training differences in pain sensation for each body region and (3) the prediction of the SEFIP score from the morphological variables for the boys and girls separately. The statistical analysis (ANOVA) found significant differences between the genders in palm width, knee diameter and foot length. Multiple regression analyses revealed an increased triceps skinfold as a significant predictor of the SEFIP score only for the female dance beginners. Pubescent girls with increased body fat probably had an increased risk of injury in a dance training program. In order to avoid pain in training with standard dance beginners, previous warm - ups of the neck, back, knees and ankles/feet muscles is recommended, especially in the case of the male subjects (according to the topological monitoring on the SEFIP score).*

Key words: *gender differences, standard dance beginners, SEFIP - score*

INTRODUCTION

Dancers often face the possibility of specific injuries, probably caused by their training program. Dancing through the pain or after injury can result in acute and chronic

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medical problems and will have negative effects on training intensity, cause a faulty technique and poor performance. Lower back pain (LBP) in Western society is a well-known major health problem which carries considerable economic and social costs. Up to 35% of those with LBP develop a chronic problem (Salminen et al., 1992; Taimela et al., 1997) which is the major limitation of activity in people under 45. Milan (1994) reported that back injuries represent 10-17% of all reported ballet injuries. The incidence of injuries in a sample of 200 Australian professional dancers was surveyed in 1989 (Geeves, 1990). The author described chronic injuries as a problem in 65% of all dancers with the most prevalent chronic injury being to the spine (34%). Disturbingly, 52 % of Australian dancers suffer from these injuries before they are 18 years of age and 75% at the age of 25.

Mc Meeken et al. (2001) suggested that the overall number of active hours is one of the risk factors for adolescent dancers' injuries. The dancers who exceeded 30 hours of physical activity each week were more likely to experience back pain. According to Murphy et al. (2003), dance injuries may occur because of human (intrinsic) factors, or be the source of hazards in the dance environment (extrinsic factor) or, as is usually the case, from a combination of the two. Human factors include age, sex, general and mental health, prior injury history, fitness level, the body mass index, body alignment, morphology, limb dominance, muscular flexibility, joint range of motion, joint laxity, muscular strength, muscular balance, and muscular reaction time. The environmental factors in the dance workplace to which dancers are exposed, which can potentially affect their health include: floor construction and incline, shoe type and shoe surface interface, room temperature, noise and light, live music tempo, costume and set design, level of the performance demand, and policies and behaviors regarding hydration, body weight regulations, conditioning practices, and work-to-rest ratios.

Garrick (1986) studied an impressive sample of ballet dancers (N = 1055), and reported that the greatest percentage of injuries were to the knee (22.3 % of all of the injuries reported), ankle (16.6%), and foot (21.6%). Askling et al. (2002) suggested that hamstring strain is one of the most common soft tissue injuries among dancers. Every third dancer (34 %) reported that they had acute injuries and every sixth dancer (17%), had overuse injuries to the rear thigh.

Therefore, preventing dance injuries is the fundamental aim of health care providers, educators, and scientists interested in the health and well-being of dancers. The identification of dance injuries is an important factor of the prevention and health care process. Most dancers often deal with their problems together with their trainers, with no proper medical attention (Bowling, 1989; Kerr et al., 1992). Continuing with their activities through the pain and/or after they are injured, can induce acute and chronic medical problems.

One possible way of monitoring dancer pain status aimed at preventing injuries is using the Self - Estimate Functional Inability because of Pain (SEFIP) questionnaire. Risk of injuriy in dance has been the subject of much research (it is reported that most injuries in dance occur to the lower back, knee and foot), but only a few have dealt with pubescent dance beginners. There are two possible risk factors for dance beginners: inappropriate training load and an intensive development process. Therefore, monitoring of the dancers pain status for beginners should be investigated in relation to their morphological status as well as in relation to their level of performance.

The aims of the present study were to:

(1) identify the morphological gender differences for dance novices,
(2) identify the post-training differences in pain sensation for each body region,
(3) define the potential morphological predictors of the SEFIP score separately for boys and girls,
(4) define the potential morphological predictors of the dance performance score separately for boys and girls.

We were of the opinion that the objectives we specified were not exclusively of scientific, but also of practical importance, since (a) possible gender differences in the SEFIP results, as well as the (b) eventual predictability of the SEFIP results using morphological measures, and (c) the possible predictability of the pair dance performance results using morphological measures will be of high applicability in adjusting the dance training for novices.

METHODS

The sample of subjects

The sample numbered 27 beginners in standard dances, 13±1 years of age. The subjects were divided into two groups, according to gender, fourteen girls and thirteen boys. No subject had any previous experience with the English waltz dance steps. The experiment lasted for 5 practice units, implemented five times a week. Each training session lasted 45 minutes.

The measuring instruments

Anthropometric measurements included: body height (BH), body weight (BW), triceps skin fold (TSK), calf circumference (CaC), palm width (PWd), knee diameter (KDm) and foot length (FLn). BH was measured in maximal inspiration, using a scale fixed to the wall (0.5 cm), BW by digital scale (0.1 kg); CaC by measuring tape (0.1 cm); the Body mass index (BMI) was calculated as follows: BMI = BW (kg) / BH (m) ^{2}. Triceps skinfold were measured by the Lange caliper. All the anthropometric measurements were collected consecutively in three items (measurements) by an experienced investigator. Reliability coefficients calculated as average inter-item-correlation ranged from 0.86 (calf skinfold) to 0.98 (body height) indicating a high intraobserver reliability. The subjects were asked to complete the SEFIP questionnaire (Figure 1) after 10 lessons of an intensive standard dance training program. Briefly, SEFIP is an instrument that asks the subjects to assess their current pain on a 5 point scale; with 0 being no pain and 4 being pain so severe they are unable to dance. The questionnaire covers 14 body regions (neck, shoulders, elbows, wrists/hands, upper back, lower back, hips, thighs (front), thighs (back), knees, shins, calves, ankles/feet; toes). A sum score (range 0 - 56) can be achieved where 0 represents no pain and 4 maximal pain. Everything above zero is regarded as a positive finding. (Ramel et al. 1999; Miletić at al. 2007.)

How do you feel just now? Do you have any musculoskeletal problems right now? Check one box for every body region, please!					
	Very well (0)	Some pain but not many problems (1)	Much pain but can handle it (2)	Much pain, must avoid some movements (3)	Can not work in the production because of pain (4)
Neck					
Shoulders					
Elbows					
Wrists/hands					
Upper back					
Lower back					
Hips					
Thighs (front)					
Thighs (back)					
Knees					
Shins					
Calves					
Ankles/feet					
Toes					

Fig. 1. The Self – Estimated Functional Inability because of Pain (SEFIP) screening questionnaire (according to Ramel et al., 1999.)

The quality of dance performance was evaluated as follows:

All of the subjects were obliged to perform four basic figures (in pairs) of a standard dance, the English waltz. The subjects' task was to correctly perform the exact English waltz dance figures: (1) The waltz steps forward/backward; (2) waltz steps in a *square* figure; (3) waltz turn forward; (4) waltz turn reverse; (5) dance style – performing the steps and turns softly, continuously and slowly; (6) conformity with the music. The beat is 3/4, and the tempo is slow. In order to avoid any subjective assessment, all of the subjects were videotaped first. Three independent judges later evaluated the performances by watching the videotaped material. The authors tried to simplify the judging procedure, (according to Magill & Schoelfender-Zohdi, 1996). Scoring was based on giving a 0, 1, or 2 for each of the 6 segments based on skill. A 0 was given if a segment was missing from the performance. A score of 1 was given if the segment was performed incorrectly, while a score of 2 was given if the segment was performed correctly. To establish an overall performance score for each trial, the 6 segment scores were totaled. Thus, the final score could range from 0 to 12. Reliability coefficients calculated as average inter-item-correlation were 0.97 for the girls and 0.96 for the boys indicating a high intraobserver reliability.

Data analysis

In addition to the descriptive statistics (Means and Standard Deviations), using the ANOVA we calculated the univariate differences between the boys and girls in all the applied variables.

When precisely analyzing the positioning of pain, we calculated the frequency and presented the percentage tables for SEFIP results.

Multiple regressions were used for the purpose of defining (1) the possible predictability of the SEFIP results using morphological predictors and (2) the possible predictability of the pair performance of the English waltz results using morphological predictors. We used the BMI, and avoided BH and BW as predictors in the multiple regressions (MR) because: (1) it would be methodologically incorrect to use BH and/or BW at the same time as their derivation - BMI; and (2) BMI allowed us to keep BH and BW variance in the predictor set, while keeping degrees of freedom at a higher level compared to the possible calculation of the MR using the BH and BW (and not BMI) as predictors. For the same reason, the selected predictor variables were restricted in the first regression analysis (according to previous investigations) and in the second regression analysis according to the ANOVA results obtained for gender differences.

All of the coefficients were considered significant at $p < 0.05$. Statsoft's Statistica was used for all the calculations.

RESULTS AND DISCUSSION

To determine the differences in the morphological status for female and male dancers the Analysis of variance (ANOVA) was calculated. The results showed significant differences (Table 1) between female and male dancers in palm width (PWd), knee diameter (KDm) and foot length (FLn). Male dancers have a more extended transversal and longitudinal dimensionality of the skeleton than female ones. Surprisingly, other investigated segments (including BMI) of the dancers' morphological status have not showed statistically significant differences.

Table 1. Descriptive statistics, the Kolmogorov-Smirnov (K-S) test for assessing the normality of distribution and the ANOVA (F) for boys and girls

	Girls		Boys		F	p
	AS±SD	KS*	AS±SD	KS*		
BH	155.5±4.1	.16	158.0± 6.9	.16	1.4	0.25
BW	49.3±8.1	.19	53.7±10.7	.18	1.4	0.24
BMI	20.2±2.6	.25	21.4± 3.7	.19	0.9	0.35
TSK	14.9 ±4.8	.17	14.9± 6.3	.10	0.0	0.99
CaC	33.4±2.5	.16	33.9± 3.2	.18	0.2	0.64
PWd	6.9±0.4	.14	7.3± 0.5	.20	**5.2**	**0.03**
KDm	9.2±0.5	.17	9.7± 0.5	.15	**5.7**	**0.02**
FL	24±1.1	.25	25.8± 1.4	.30	**14.6**	**0.00**
pair dance performance	9.0±3.2	.19	7.8± 3.5	.18	1.0	0.32
SEFIP	2.7±3.5	.25	3.8± 3.6	.17	0.7	0.42

*KS significance for: d>0.36

As presented in Table 1, the groups of subjects did not differ in the overall SEFIP results, or in the waltz dance performance score. Probably because of the relatively high variability of results (SD), the groups do not differ in the SEFIP results and dance per-

formance was evaluated in pairs. In that case, significant gender differences were not expected.

Table 2. Pain intensity and Location grades as 0, very well, 1, some pain, 2, much pain but can handle it, 3, much pain, must avoid some movements, 4, cannot dance because of pain.

	Girls SEFIP						Boys SEFIP					
	0	1	2	3	4	%	0	1	2	3	4	%
Neck	11	3	0	0	0	21.4	9	2	0	1	1	**30.7**
Shoulders	12	1	1	0	0	14.3	11	2	0	0	0	15.3
Elbows	13	1	0	0	0	7.1	12	1	0	0	0	7.7
Wrists /Hands	14	0	0	0	0	0.0	11	2	0	0	0	15.4
Upper back	10	4	0	0	0	**28.6**	6	7	0	0	0	**53.8**
Lower back	11	2	1	0	0	21.4	9	4	0	0	0	**30.7**
Hips	13	1	0	0	0	7.1	12	0	0	1	0	7.7
Thighs (front)	12	0	0	2	0	14.3	11	1	0	0	1	15.3
Thighs (back)	12	1	0	1	0	14.3	11	1	0	0	1	7.7
Knees	11	3	0	0	0	21.4	9	4	0	0	0	**30.7**
Shins	14	0	0	0	0	0.0	12	1	0	0	0	7.7
Calves	12	1	0	1	0	14.3	10	3	0	0	0	23.1
Ankles /feet	11	3	0	0	0	21.4	8	3	0	2	0	**38.4**
Toes	13	1	0	0	0	7.1	11	2	0	0	0	15.3

When observing the positioning and intensity of pain, it is evident that the subjects from both groups mostly complained of pain in the back region. The pain status for male dancers, according to SEFIP questionnaire, was more complex. They reported upper back pain (53. 8%) more frequently than female dancers (28. 6%), followed by pain status reported in the ankles and feet (38.4%), lower back, neck and knees (30. 7%).

However, the obtained results support previous investigations (Salminen et al. 1992; Taimela et al. 1997). These authors warned of the alarming problems with back pain especially with young dancers. About one-third of young people enter adulthood having already experienced disabling back pain (Balague & Nordin, 1992; Burton et al., 1996) and a significant proportion of these are linked to sport or dance. According to Mc Meekenan et al. (2001), of the young people who had experienced back pain in the previous year, 60% had experienced a recurrence of pain. In the present research even beginners in the process of training have already reported back pain. That could be the consequence of two important factors: inappropriate training load and an intensive development process. In order to avoid pain occurrence in training with standard dance beginners, special training methods with the emphasis on flexibility and strength training of the neck, back, knees and ankles/feet muscles is recommended, especially with the male subjects.

However, whether adolescent back pain is considered "normal life experience" (Burton et al.1996.) or a "serious public health problem" (Olsen et al., 1992.), future investigation of the relation between morphological status and pain intensity is needed.

In the present research, the significant prediction of the SEFIP score by means of the selected morphological measures is observable only for the female group of subjects (Table 3).

Table 3. Multiple regression results concerning the prediction of the SEFIP score from selected morphological variables for the girls and boys samples

	Girls BETA	Boys BETA
BMI	0.06	1.40
TSK	0.83 **	-0.04
CaC	-0.11	-1.16
RO	0.79 **	0.50

Data expressed as BETA coefficient, BMI, body mass index, R multiple correlation
* denotes significant coefficients

On the basis of the values of the multiple correlation coefficient (R=.79), it can be concluded that a very strong linear connection exists between the predictor variables and the criterion variable. On the basis of the regression coefficient analysis and its significance obtained from the values of BETA-coefficients, it can be concluded that the greatest influence on the criterion variable comes from the TSK (triceps skinfold) predictor variable. Increased fatty tissue predicts increased pain status only among female dancers.

The position of the female dancer when her partner is holding her in standard dance is such that it demands a high degree of mobility of the spinal column. Due to those findings, reduced body fat and a proper training load should be one of the most important segments of preventing back injuries among female dancers. If the flexibility and strength exercises were not properly performed, back pain during a dance performance would probably increase.

Monitoring of the dancers' pain status for beginners in the present research was investigated in relation to their level of performance as well.

On the basis of the value of the multiple correlation coefficient (R= .84), it can be concluded that a very strong linear connection exists between the predictor variables and the criterion variable, the success in the waltz dance performance for females (Table 4).

Table 4. Multiple regression results concerning the prediction of the pair performance of English waltz score from selected morphological variables for the girls and boys samples

	Girls BETA	Boys BETA
BMI	0.57	-0.37
PWd	0.66 **	0.86
KDm	-1.38 **	0.63
FL	0.02	-0.61
RO	0.84 **	0.50

Data expressed as BETA coefficient, BMI, body mass index, R multiple correlation
* denotes significant coefficients

For the analysis of the influence of certain variables on the criterion variables, a standardization of the regression coefficient was carried out and the value for Beta was obtained. The greater its absolute value, the more influence the variable has on the criterion variable. On the basis of the regression coefficient analysis and its significance obtained

from the value of BETA-coefficients, it can be concluded that the greatest projections on the criterion come from the predictor variables knee diameter (KDm) and palm width (Pwd).

The results obtained in Table 1 indicate a higher level of dance performance for the female group of subjects (Mean = 9.0) than for the male group of subjects (Mean = 7.8) in the waltz dance performance.

Better dance performance of the female groups in the same learning situation were expected and should be correlated by means of psychomotor coordination and all the relevant anthropologic characteristics, closely associated with the process of development which is individual and is based on maturation. The maturity status influences physical performance (Beunen et al, 1998.) of boys and girls differently. More mature girls have greater physical performance than their less mature peers (11-13 years) and inter-individual differences in motor performance depend on growth and maturation, especially among boys. The mean age at PHV (peak high velocity) among boys in Europe and America fluctuates on average between 13.4 and 14.4 years of age, while the mean age at PHV among girls fluctuatea on average between 11.4 and 12.2 years of age. The increased values of palm width, knee diameter and foot length could be considered as an early maturation process for the male group of subjects. In this investigation, females perform waltz dance better and that could be connected with their more stabile maturation status at the age of 13. An increased growth process could be the reason for clumsy performance, while a stable growth process among females, on the other hand, caused a more precise, sophisticated, and harmonious dance performance. The positive significance of the palm width (PWd) variable in assessing a good performance only for the female group of subjects (obtained by the value of BETA-coefficients) could also be related to the stable growth process among the female subjects.

It is generally accepted that musculature can enhance its endurance status by two relatively independent means: (1) the anatomical development or hypertrophy, and (2) functional development. Hypertrophy results in an increase of the energetic potential of the muscles, while functional development is a result of the increased biochemical tolerance of the working muscles and/or improved intra- and inter-muscular coordination (Miletić et al., 2007.) Both changes are relatively well documented among athletes, but later changes are more frequent in females because of the relative (compared to men) deficiency of the anabolic hormones, which directly limits the hypertrophy dynamics and potential (Sanborn & Jankowski, 1994; Wilmore & Costill, 1998). Therefore, the "calf functionality" increases, and initiates a relationship between KDm and dance performance. From this point of view, the significance of knee diameter (KDm) variable in assessing good performance (obtained by the value of BETA-coefficients) could be explained.

CONCLUSION

The morphological differences of standard dance beginners, aged 13±1, were defined based on the results obtained in the present study. Male dancers have a more extended transversal and longitudinal dimensionality of the skeleton than female ones (according to the significant differences obtained between female and male dancers in palm width, knee diameter and foot length.

Monitoring of the dancers' pain status aimed at preventing injuries, using the Self - Estimate Functional Inability because of Pain (SEFIP) questionnaire, was in accordance with previous investigations showing alarming *back pain problems* of young dancers. Even beginners in a training process, young dancers, especially males, already report back pain to a serious extent (53.8%), probably caused by inappropriate training load and/or an intensive development process. In order to avoid pain occurrence in training with standard dance beginners, special training methods with an emphasis on flexibility and strength training of the neck, back, knees and ankles/feet muscles is recommended, especially among male subjects.

Reduced body fat and a proper training load should be one of the most important segments of preventing back injuries among female dancers. If the training load and exercise duration are not properly planned and performed, back pain during dance performance will probably increase. Maturation differences could be the reason for the better dance performance of the girls in the present study. Future studies based on the anthropologic features of pre-pubescent and pubescent boys and girls, correlated with the obtained results are necessary.

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MORFOLOŠKE RAZLIKE I MONITORING STATUSA BOLA U TRENINGU PLESA

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Svrha ovog istraživanja je da se identifikuje uticaj nekih morgoloških karakteristika na SEFIP skor kroz detekciju morfoloških razlika 13±1 (N=27) starih devojčica i dečaka, početnika u sportskom plesu. SEFIP je meren posle 10 časova treninga standardnog plesa. Morfološke varijable su merene na početku studije i uključivale su:visinu, težinu, body mass index (BMI), kožni nabor tricepsa, obim trupa, dijametar kolena i dužina stopala. Analizirali smo (1) razlike između devojčica i dečaka kod svih varijabli, (2) post-trenažne razlike u osetu bola za svaki region tela i (3) predviđanje SEFIP skora na osnovu morfoloških mera posebno za devojčice i dečake. Statističko analizom (ANOVA) su pronađene značajne razlike između polova u širini dlana, dijametru kolena i dužini stopala. Multipla regresija je otkrila da je kožni nabor tricepsa značajan prediktor SEFIP skora samo kod devojčica početnica u sportskom plesu. Devojčice u pubertetu sa povećanim masnim tkivom verovatno su imale povećan rizik povreda u treningu plesa. U cilju izbeganja pojave bola u treningu standardnog plesa kod početnika, predlaže se zagrevanje mišića vrata, leđa, kolena i stopala, naročito kod dečaka (prema topološkom monitoringu SEFIP skora).

Ključne reči: *polne razlike, početnici u sportskom plesu, SEFIP- skor*