Journal of Physical Education and Sport ® (JPES), 18(3), Art 262, pp. 1796 - 1800, 2018
online ISSN: 2247 - 806X; p-ISSN: 2247 – 8051; ISSN - L = 2247 - 8051 © JPES

Original Article

Relationship between the correct running technique and lower back well-being perceived by the practitioner

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Published online: September 30, 2018
(Accepted for publication September 11, 2018)
DOI:10.7752/jpes.2018.03262

Abstract:
Running is the most popular sporting activity in the world due to its low cost and health benefits for people of all ages. It is associated with a high prevalence of injuries in the lower part of the body especially in the novice runners. Knowing the correct biomechanics and optimal running technique is very important for the prevention of such injuries.Thus, the purpose of this study was to investigate the relationship between the correct running technique and the lower back well-being perceived by the practitioner. 96 long distance runners (27 F, 69 M; 38.13 ± 11.12 years) of which 35% trains at amateur level and 65% participates in the federal competitions, volunteered to participate in this study. Subjects responded to a questionnaire requesting age, sex, weight, height, the training mode and to the Oswestry Low Back Pain Questionnaire assessing the low back disability index (%). Significant differences ($p < 0.05$) were found between the group of female runners performing the running technique exercises and postural prevention sessions, and the one performing the running technique exercises but no postural prevention sessions (6.75 ± 2.53 vs. 1.60 ± 1.39 %, $p = 0.037$, $f = 0.22$). Our findings suggest that subjects that in their training take care of both the postural and the mechanical aspect of running, show a higher disability index than others. This could be explained by the increased perception of one's own body by the subjects who perform postural prevention sessions.
Keywords: postural; injury; proprioception; disability index; spine; stability.

Introduction

Human performance, especially in one of the most widespread sports activities such as running, is influenced by the state of the musculoskeletal system, the level of training and conditioning of biological structures or simply by physiological aging (Matias, Taddei, Duarte & Sacco, 2016). Running is the most popular sporting activity in the world due to its low cost, versatility, convenience (Paluska, 2005) and health benefits at all ages (Haskell et al., 2007). Because of this accessibility, the running is associated with a high prevalence of injuries in the lower part of the body (percentages range between 19.4 and 79.3%) (van Gent et al., 2007) and these percentages are high especially in the novice runners (Buist et al., 2010; Tonoli, Cumps, Aerts, Verhagen, & Meeusen, 2010). Knowing the correct biomechanics and optimal running technique is very important for the prevention of such injuries: correct biomechanics of running, in fact, implies synchronized movements of all components of the kinetic chain while a misalignment of the lumbar spine with the lower limbs can cause an alteration of the mechanics and thus cause injuries (Dugan & Bhat, 2005). Injuries can be caused by intrinsic and extrinsic factors. Intrinsic factors include alterations of biomechanical force distribution patterns, training volume, past injuries and non-alignment of hips, knees and ankles; among the extrinsic factors, on the other hand, the training surface and the type of footwear used are included (Van Der Worp et al., 2015).

In the literature it is known that fatigue caused by prolonged running involves changes in biomechanics emphasizing forward flexion of the trunk; fatigue of the trunk muscles can cause a reduced ability to maintain a vertical posture during running (Koblbauer, van Schooten, Verhagen, & van Dieen, 2014; Meardon, Hamill, & Derrick, 2011). In addition, Seay, Van Emmerik, and Hamill (2011) demonstrated that subjects with pain in the lumbar spine show negative postural adaptations during running due to reduced coordination between the lumbar spine and the pelvis compared to adaptations during walking. Finally, after having done strenuous exercises to the lumbar paraspinal muscles before a jogging session, it was shown that subjects presenting pain in the lumbar spine showed a reduced propensity for postural adjustment during running and therefore a greater need to stabilize the trunk and lumbar spine for the prevention of injuries (Hart, Kerrigan, Fritz, & Ingersoll, 2009).

The introduction of prevention protocols in the training program or in individual sessions helps to avoid the disorders mentioned above. Lňpez-Minarro, Muyor, Belmonte and Alacid (2012) have shown that introducing protocols that include four active stretching exercises based on ischiocrural can be effective in preventing injuries. In fact, the stretching of these muscles can be related to an improvement in the anterior pelvic tilt and to a greater lumbar flexibility. In addition, an eight-week training program with specific exercises

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to strengthen the ankle muscles and stabilize the joint reduces the intrinsic injury risk factors in the novice runners (Baltich, Emery, Stefanyshyn and Nigg, 2014). Finally, Buist et al. (2008) have shown that in a "10% rule" training program designed to avoid injuries to the lower limbs and back caused by running and which consists of increasing the training load by no more than 10%, in novice runners does not lead to differences in injuries incidence compared with a standard 8-week training program. The latter study suggests that the incidence of injuries does not depend solely on the correct administration of the training load but also on the biomechanical management of the same.

However, the relationship between the correct running technique and the perception of low back health status is less well known in the literature. In fact, little is known about the effects that the optimization of running technique can cause and if all this can make running training less dangerous for those looking to keep fit only. Therefore, the purpose of this study was to investigate the relationship between the correct running technique and the lower back well-being perceived by the practitioner.

Materials & Methods

Research design

In this research, a causal-comparative study design also known as ex post facto was used in order to collect the data from the Oswestry Low Back Pain Questionnaire and compare the groups (Cohen, Manion, & Morrison, 2011).The results of the comparative analysis were defined by statistically significant differences between the groups represented by the crossing of the two levels of the three independent variables (male/female, yes/no running technique, yes/no postural prevention).

Participants

In total, ninety-six (n=96) subjects (n=27 females and n=69 males; age: 38.13 ± 11.12 years; body height: 172.48 ± 7.6 cm; body mass: 69.22 ± 10.21 kg; and BMI 23.20 ± 2.60 kg/m^2; mean ± SD) volunteered to participate in this study.

All subjects practice long-distance running, 35% trains at amateur level and 65% participates in the federal competitions. In addition, 66% of subjects perform running technique exercises and 40% perform complementary sessions of postural prevention. Among the subjects in the sample, 32% perform training sessions taken care of by a federal technician, and 68% prefer to personally take care of their training sessions.

Subjects who practice marathons or triathlons have been excluded from the study because the physiological adaptations of the organism to strenuous physical activity are different and could have influenced the results of the study.

All participants were recruited in Apulia (Italy) and received a complete explanation in advance about the purpose of the study and provided their informed consent. This study has been performed in accordance with the ethical standards laid down in the Declaration of Helsinki and conducted in May 2018.

Procedures

To carry out the study an online questionnaire was sent which was voluntarily answered and the data were collected anonymously. Subjects were given a questionnaire requesting age, sex, weight, height, the training mode and a low back health assessment questionnaire. The participants were asked if they took part in federal competitions, if the training sessions were taken care of by a technician or personally, if they performed exercises aimed at improving the running technique and, finally, if they performed complementary sessions of postural prevention such as sessions of postural gymnastics, Pilates, core training.

Instruments

The *Oswestry Low Back Pain Questionnaire* (Monticone et al, 2009) was used to assess the level of wellbeing of the lower back. It was chosen for its excellent psychometric characteristics and ease of administration. The questionnaire examines perceived level of disability in 10 everyday activities of daily living that can be affected by low back pain: the first item allows a specific description of pain intensity, all other items (personal care, lifting, walking, sitting, standing, sleeping, sexual activity, social life and traveling) examine the limitations due to low back pain in everyday life. Each item includes six possible statements related to different degrees of limitation in the same type of activity. Referring to the current situation, the subject must choose between six answers on a six-point Likert scale, corresponding to a score ranging from 0 to 5 where the number 5 represents a greater disability. The maximum possible score is 50 and is expressed as a percentage. In this study the questionnaire showed a reliability and internal consistency acceptable (Cronbach's $\alpha = 0.72$).

Statistical analyses

All analyses were performed using the SAS Jmp Statistics (Cary, NC, USA) version 14.0.0 and the data are presented as group mean values and standard deviations. The presence of three independent variables on two levels (male/female, yes/no running technique, yes/no postural prevention) made it necessary to use a fixed effects factorial design analysed through a 2x2x2 ANOVA that allowed compare the groups with respect to the dependent variable "Oswestry index", i.e. the low back disability index. The standardized Cronbach's alpha

coefficient (Cohen et al., 2011) was used as a measure of reliability of the Oswestry Low Back Pain Questionnaire. Additionally, classification of the effect size *(f)* was used to estimate the magnitude of differences within each group by calculating the partial η2. According to Cohen (1988), $0.00 \leq f \leq 0.24$ indicates a small effect, $0.25 \leq f \leq 0.39$ indicates a medium effect, and $f \geq 0.4$ indicates a large effect. The significance level was set a priori with $p < 0.05$.

Results

From the statistical analysis of the data obtained from the questionnaire, crossing the levels of the variables, no significant differences between the male runners were found. On the contrary, significant differences were found between the group of female runners performing the running technique exercises and postural prevention sessions, and the one performing the running technique exercises but no postural prevention sessions ($F_{1,95} = 4.493$, $p = 0.037$, $f = 0.22$). The following Table 1 summarizes the low back disability percentage values obtained by the groups.

Table 1 - Percentage values obtained from the administration of the Oswestry Low Back Pain Questionnaire. The values are shown as M ± SD.

	FEMALE								**MALE**							
	Running technique								**Running technique**							
	No				**Yes**				**No**				**Yes**			
	Postural prevention				**Postural prevention**				**Postural prevention**				**Postural prevention**			
	No		**Yes**		**No**		**Yes**		**No**		**Yes**		**No**		**Yes**	
O.I.	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD
(%)	2.00	1.41	0.80	0.49	1.60	1.39	6.75	2.53	3.60	1.04	6.00	3.56	2.17	0.64	2.95	1.09

Note: O.I. = Oswestry index.

In the following Figure 1 the low back disability percentage values obtained by the groups are represented graphically.

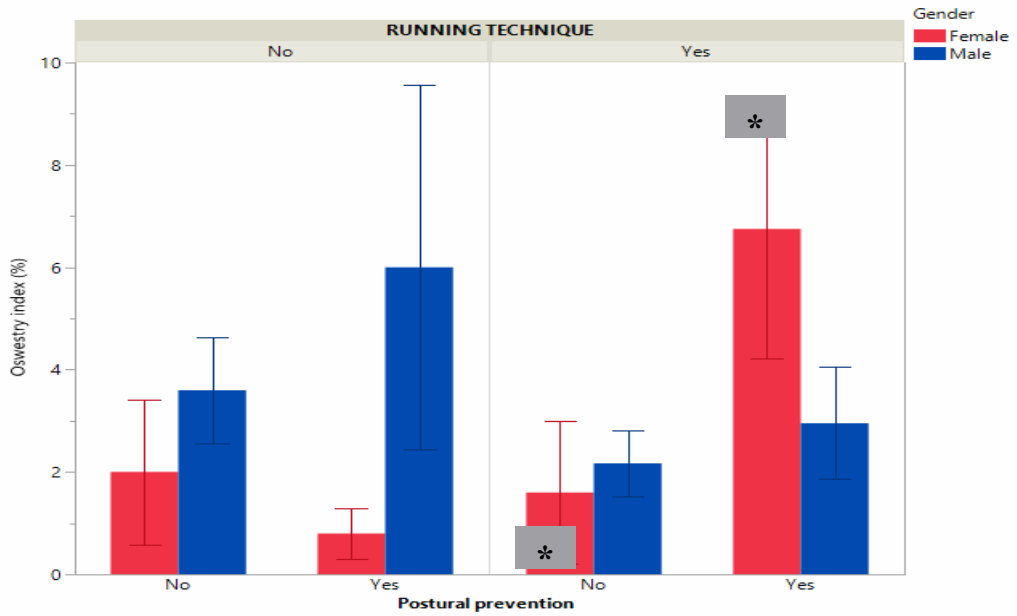

Fig. 1. Percentage of the Oswestry index referring to subjects non-performing/performing running technique exercises and postural prevention. The values are shown as M ± SD. *Significant difference between the group of female runners performing the running technique exercises and postural prevention sessions, and the one performing the running technique exercises but no postural prevention sessions ($p<0.05$).

Discussion & Conclusions

The aim of this study was to investigate the relationship between the correct running technique and the lower back well-being perceived by the practitioner. The results showed that precisely the most trained subjects, who included in their training routine trunk enhancement exercises (for example postural gymnastics, core training and Pilates) and exercises to improve the mechanics of the running, showed a greater index of disability, in disagreement with the previous studies (Baltich et al., 2014; Buist et al., 2008; Lňpez-Minarro et al., 2012).

In fact, it is well known that strengthening the muscles of the trunk and abdominals contributes to lumbar stabilization (Cho & Jun, 2014), and exercises aimed at trunk stability (e.g. with the Pilates method) can contribute to maintaining the spine balance (Muscolino & Cipriani, 2004). In addition, Endleman and Critchley (2008) reported that intense training with the Pilates method performed for six months by 18 female and 8 male healthy adults, causes a significant improvement of the strength of the transverse and internal oblique muscles, demonstrating the effectiveness of the core training on abdominal strength and trunk stability. Also, alterations in the running mechanics observed in injured practitioners have been attributed to muscle force deficit. In fact, there is a significant relationship between the strength of the trunk musculature and the internal rotation angle of the hip, indicating that a decrease in this resistance can lead to injuries during the running training. Therefore, an injury prevention program should aim not only at strengthening the trunk muscles but also at neuromuscular hip control (Schmitz, Russo, Edwards & Noehren, 2014).

Based on previous research, train both the optimal running technique and stabilizing muscles should result in general physical well-being, but the results of the present study do not confirm the previous theories. This could be explained by the increased perception of one's own body by the subjects who perform postural prevention sessions. Proprioception is the perception of the location of the body segments and therefore of the movement of the body in space as well as the perception of muscular tension and balance. The nervous system receives information from the proprioceptors allocated in the muscles (neuromuscular spindles) and in the tendons (Golgi tendinous organ), in the joints and in the skin, which transmit related information regarding the mechanical stimuli generated by the skeletal muscle system (Stillman, 2002). Several studies show that the postural and physical training influences positively the joint proprioception (Ashton-Miller, Wojtys, Huston & Fry-Welch, 2001; Pŕnics, Tŕllay, Pavlik & Berkes, 2008; Salles et al., 2015).

This study has some limitations that need to be acknowledged. A major limitation of the present study is related to use of a causal-comparative study design providing weaker evidence for causation as there is no manipulation of the independent variables. Moreover, due to the small sample size the results from the study should be interpreted with caution; therefore, further studies are also needed to increase the sample. However, the results obtained could provide important indications for future studies conducted with experimental design that aims to know the causal relationship between the correct running technique and the physical well-being perceived at the lower back level by the practitioner.

In summary, our findings suggest that subjects that in their training take care of both the postural and the mechanical aspect of running with specific exercises, show a higher disability index than others. This could be due to the increased perception that the subjects who perform postural prevention sessions have of their body. This is a positive aspect as these subjects could quickly recognize the disorders related to the musculoskeletal system, before they become chronic and harmful. However, it is always advised to be guided during the training by an expert in the sport sciences, whether the training purpose is competitive or whether recreational sport activity is carried out. Only an expert in sports science has the skills to manage intensity and training volumes, knows the effects of the exercises it offers and can identify any problems related to the biomechanics of the movement.

Conflicts of interest - The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Authors' contribution

Gianpiero Greco contributed to research design and conception, data analysis and interpretation, writing and critical review of the manuscript. Martina Settimo contributed to research design, data acquisition and interpretation. Francesco Fischetti contributed to research design, data interpretation, writing and critical review of the manuscript. All authors have read and approved the final manuscript.

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