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Effects of Breast Motion on Lower-Body Kinematics during Running

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Abstract We measured the effects of breast motion on lower-body kinematics during overground running. Thirty female participants aged 18–60 years completed two blocks of three trials each of overground running for 25 m at self-selected pace under two conditions: with and without breast support provided by a sports bra. Participants' body movements were analyzed with 18 parameters characterizing breast and lower-body kinematics. Sports bra use reduced breast motion and increased about 83% of the lower-body kinematic parameters, including running velocity; stride length; foot clearance; vertical and lateral center of mass displacement; and thorax, hip, knee, and ankle range of motion (all $p < 0.05$). Among the changed characteristics, the stride length, center of mass displacements, thorax and knee range of motions correlated negatively ($r = –0.25$ to $–0.46$) with the velocity of breast motion. Therefore, the reduction of breast motion may improve lower-body kinematics during running, which may influence sport and leisure performance.

Keywords Sports Bra, Sport Exercise, Gait

1. Introduction

Running is a complex motion that involves whole body movement and serves multiple purposes, including a sport or leisure aerobic activity [1]. As more people engage in running to maintain healthy lifestyles and participate in sports, the investigation of factors that influence running is important.

One factor that affects running performance in females is excessive breast motion [2]. Such effects are increasing with the obesity epidemic and the availability of breast augmentation procedures [3]. Excessive breast motion during exercise increases pressure and pulling force on the Cooper ligaments, pectoralis muscles, and ribs [4], and adds load to the thoracic and cervical spine [5]. As a result, excessive breast motion is frequently associated with discomfort, embarrassment, and postural abnormalities [6-7].

Proper breast support has been proposed to reduce discomfort and improve performance in sports and other activities requiring intensive movement of the whole body. The first sports bra was developed in 1977 to provide additional breast support that regular bras could not offer [8]. Since then, the sports bra industry has advanced, with the design of increasingly complex and competitive products [6]. This industry development has, in turn, stimulated research on the effects of various forms of breast support on women's comfort during exercise. Wearing a sports bra during physical activity has been accepted to decrease pain and discomfort [6] by minimizing vertical and lateral breast displacement [9]. It has been also agreed that effectiveness of sports bras in reducing undesired breast motion varies depending on the product type and/or brand and the type of physical activity [10-12].

To date, the effects of breast motion reduction have been studied mostly during running, the most typical high-intensity physical activity. Changes in breast kinematics are well documented, but less is known about changes in the kinematics of running related to excessive breast motion. A few studies have been performed, but they have produced limited and ambiguous results. McGhee et al. [13] reported that different breast support conditions influenced stride frequency among women running on a treadmill and in water. The researchers interpreted this effect as a protective mechanism used by the participants to lessen breast discomfort. In contrast, White et al. [9] found that stride length and frequency during running did not differ between breast support conditions. This research group also showed, that the running body produces higher medial impact forces under the no-bra condition [14].

Finally, Milligan et al. [15] found that high breast support reduced the torso and upper arm ranges of motion (ROMs) in female runners, approximating a running pattern to that is more economical and beneficial for long distances. Thus, some evidence of changes in running patterns due to the wearing of sport bras has been accumulated, but it is insufficient to fully understand the effects of breast motion on the kinematics of self-paced running.

Considering these shortcomings, the present study was designed to analyze and compare lower-body kinematics during overground running with and without breast support. We hypothesized that unsupported breast motions would influence running kinematics in the lower extremities and trunk. The results could contribute to women's improved performance in sports and physical activities.

2. Materials and Methods

2.1. Subjects

With institutional review board approval, 30 female participants aged 18–60 volunteered and gave written informed consent to participate in this study. Due to data corruption, results from two participants were not included in the analysis. All participants were currently aerobically active on at least 1 day a week, had no history of breast surgery, and had not given birth or breast fed within the last year. Participants' breast size, measured as the difference between breast circumference and rib circumference, ranged widely from 8.5 to 21.5 cm, corresponding to the commonly accepted bra cup sizes of AA–DD.

The initial sample size of 30 subjects was determined based on the literature review, and consistent with sample size used in most studies testing medical devices and apparel. Interim power analysis was performed after collecting data from the first 10 participants and the results ensured power of at least 85% at significance level of 0.05 with planned number of subjects.

2.1. Experimental Procedure and Data Analysis

Participants completed two blocks of three trials each of overground running for 25 m at a self-selected speed under two randomized experimental conditions: with supported (sports bra) and unsupported (control) breasts. The Shefit Ultimate Sports Bra (Shefit, Hudsonville, MI, USA) was selected as the experimental sports bra from among five products based on its quality, as tested and described in a previous work [12]. A trained bra fitter ensured that the sports bra fit each participant properly. Before the trials were performed, the participants were instructed to practice overground running to familiarize themselves with the distance and movement pattern. Overground running was chosen as an experimental paradigm to increase applicability to normal physical activity patterns, with no limitation to treadmill running.

During running, participants' body movements were captured with a Vicon T160 system (Vicon Industries, Inc, Centennial, CO, USA) at 100 Hz. Subjects wore 47 retro-reflective 1-cm markers placed strategically over the following landmarks: the bilateral acromioclavicular joint line, mid-arm, lateral epicondyle, radial styloid, dorsal mid-carpals, nipple, anterior superior iliac spine, posterior superior iliac spine, greater trochanter, lateral malleolus, mid-leg, calcaneus, and lateral knee joint line; the eighth thoracic vertebra, seventh cervical vertebra, suprasternal notch, xiphoid process, right mid-back, occiput and frontalis line of the head; and four markers on each breast in the area surrounding the nipple (Figure 1). Previous studies have determined that the center of the nipple is a reliable landmark for the placement of a retro-reflective marker to measure vertical, mediolateral, and anteroposterior breast displacement in relation to the movement of the trunk [16]. The markers were placed directly over the nipple for control trials, and indirectly on the nipple over the bra fabric for the sports bra trials.

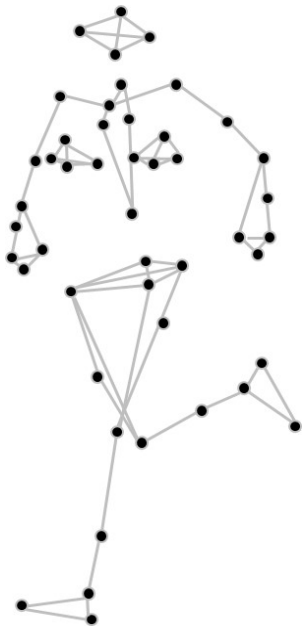

Figure 1. Standard marker placement setup with 47 retro-reflective markers on anatomical landmarks and the bilateral breast

The Vicon Plug-In Gait model, adjusted to accommodate the breast markers, was used to calculate two groups of outcome measure: breast kinematics and lower-body kinematics (spatiotemporal characteristics, body stability, and angular joint displacement).

Breast kinematics were computed using trajectories of nipple marker displacement from the right breast relative to thorax marker displacement in three planes and included the ranges of lateral and vertical breast displacement and maximal lateral and vertical breast velocities.

Lower-body kinematics were represented by the spatiotemporal characteristics of running and were

calculated using trajectories of the right lower extremity, including cadence (number of steps per minute), velocity (distance of the body over step time), single support time (relative time of one foot's contact with the ground), stride length (distance between two consecutive heel strikes of the same foot), step width (maximum perpendicular distance between heels), and foot clearance (maximum distance from the toes to the ground). Body stability measures included the center of mass (COM) average lateral displacement (root mean square of the COM per step in the lateral direction), COM lateral range (difference between maximum and minimum lateral COM displacements), COM average vertical displacement (root mean square of the COM per step in the vertical direction), and COM vertical range (difference between maximum and minimum COM displacements in the vertical direction). Angular joint displacement measures included the rotational thorax ROM in the horizontal plane and the hip, knee, and ankle ROMs in the sagittal plane. All measures except the thorax ROM were calculated for the right lower extremity per step and averaged across at least five to six steps.

Statistically, differences in running and breast kinematics between the supported and unsupported conditions were assessed using parametric dependent *t* tests with a significance level of $p < 0.05$, after data normality distribution was confirmed with the Kolmogorov-Smirnov test. Pearson coefficients were used to examine correlations between the velocity of breast motion and measures of lower-body kinematics that differed significantly between conditions. Coefficients of $r > 0.25$ indicated mild correlation, and those of $r > 0.40$ indicated moderate correlation [17].

3. Results

Sports bra use resulted in significant reductions in all breast kinematic parameters, ranging from 44% to 61% for lateral and vertical displacement, and from 50% to 52% for vertical and lateral peak velocities (all $p < 0.05$; Table 1). Among spatiotemporal characteristics of running, cadence ($p = 0.051$), velocity ($p = 0.008$), single support time ($p = 0.011$), stride length ($p = 0.003$), and foot clearance ($p < 0.001$) were increased significantly under the breast-supported condition (Table 2). Step width and cadence did not show significant difference but tendency to change. Sports bra use significantly increased the average ($p = 0.007$) of vertical ($p = 0.007$) and lateral ($p = 0.026$) COM displacement. The range of COM displacement was also increased in vertical direction only ($p = 0.005$). No significant difference found for lateral COM range ($p = 0.222$) (Table 2). ROM increased during running with supported breasts for all angular displacements ($p < 0.05$).

Across both breast support conditions, mild to moderate negative correlations were found between breast velocities and stride length ($r = –0.46$ and $r = –0.37$). The velocities of breast motion also correlated with the COM vertical displacement range ($r = –0.44$) and average ($r = –0.26$ and $r = –0.34$), and with the thorax and knee ROMs ($r = –0.28$ and $r = –0.25$, respectively; Table 3). No correlation was found between breast motion and other lower-body kinematic measures, including velocity, foot clearance, and hip ROM.

Table 1. Breast kinematics measures under two overground running conditions (n=30).

Breast kinematics measures	Running conditions		P-value
	Control	Sports Bra	
Range Lateral Displacement (cm)	6.68 ± 3.09	3.74 ± 0.015	<0.001*
Range Vertical Displacement (cm)	4.43 ± 2.18	1.7 ± 0.48	<0.001*
Peak Lateral Velocity (cm/s)	74.0 ± 34.1	36.6 ± 17.0	<0.001*
Peak Vertical Velocity (cm/s)	48.7 ± 20.7	23.1 ± 14.9	<0.001*

Values are presented as means ± standard deviations. *p < 0.05.

Table 2. Lower-body kinematics measures under two overground running conditions (n=30)

	Running conditions		P-value
	Control	Sports Bra	
Spatiotemporal measures			
Cadence (steps/min)	179±21.4	183±19.8	0.051
Velocity (m/s)	3.49±0.88	3.71±0.72	0.008*
Single Support Time (%)	40.6 ± 6.04	38.8±4.74	0.011*
Stride Length (m)	2.31±0.33	2.42±0.31	0.003*
Step Width (cm)	6.21 ± 2.30	6.75 ±.2.53	0.060
Foot Clearance (cm)	25.4 ± 9.77	28.9 ± 8.70	<0.001*
Body stability measures			
COM Average Lateral Displacement (mm)	1.14 ± 0.59	1.24 ± 0.65	0.026*
COM Lateral Range (mm)	119 ± 76.1	124 ± 83.4	0.222
COM Average Vertical Displacement (mm)	4.38 ± 0.75	4.68 ± 0.64	0.007*
COM Vertical Range (mm)	97.8 ± 22.7	105 ± 19.5	0.005*
Angular joint measures			
Thorax ROM°	32.0 ± 8.63	34.9 ± 6.51	0.001*
Hip ROM°	76.3 ± 14.4	80.2 ± 18.0	0.007*
Knee ROM°	101 ± 16.6	109 ± 17.0	0.004*
Ankle ROM°	55.0 ± 7.16	56.8 ± 7.61	0.019*

Values are presented as means ± standard deviations. *p < 0.05. COM -Center of Mass; ROM – Range of Motion

Table 3. Pearson coefficients of correlation between breast and lower-body kinematics measures (n=30).

Lower-body kinematics measures	Breast Kinematics Measures	
	Maximal Velocity Lateral (cm/s)	Maximal Velocity Vertical (cm/s)
Velocity (m/s)	*r* = -0.11	*r* = -0.10
Stride Length (m)	*r* = -0.46	*r* = -0.37
Foot Clearance (cm)	*r* = -0.14	*r* = -0.08
COM RMS Vertical Displacement (mm)	*r* = -0.26	*r* = -0.34
COM Vertical Range (mm)	*r* = -0.44	*r* = -0.18
Thorax Horizontal ROM°	*r* = -0.28	*r* = -0.21
Hip Sagittal ROM°	*r* = 0.04	*r* = 0.08
Knee Sagittal ROM°	*r* = -0.19	*r* = -0.25

COM -Center of Mass; ROM – Range of Motion; RMS- Root Mean Square

4. Discussion

The present study investigated the effects of breast support on lower-body kinematics during overground running. The results indicated that about 85% of kinematic parameters examined were affected by unsupported breast motion. This finding was partially supported by the mild to moderate correlations observed between the changed kinematic parameters and breast motion velocities. The findings suggest that sports bra use has the potential to significantly improve performance in overground running.

Running is a complex activity that involves whole body movement, and is traditionally assessed by examination of multiple parameters. Thus, several questions arise when considering the significance of the present findings. The first question is whether changes in lower-body kinematics indicate improvement in running performance. Traditionally, the quality of running is defined by velocity, with faster considered to be better. Similar to the gait pattern, the velocity of running is a derivative of multiple factors, such as the step or stride length and frequency. Increased velocity is achieved initially through increasing step length, followed by increasing cadence [18]. In turn, the increase of step or stride length requires mechanically greater ROMs in the major participating joints of the lower extremities and trunk [19]. Thus, the increased spatiotemporal and angular joint parameters during sports bra use could be considered to reflect improvements or to be positive effects. The results of our study are consistent with those of another study showing that proper breast support reduces discomfort, thereby improving running performance [9]. However, the authors also reported no effect of breast support on stride length or frequency during overground running. These discrepancies in results may arise from the use of different experimental designs. In our study, participants ran a longer distance, which allowed them to achieve faster speeds that might have amplified the effect of unsupported breast motion on running performance. Another explanation different results may arise from the self-selected speed of running that was not controlled in our study.

Another controversy derives from the study of Milligan et al. [15], who reported reduced torso and upper arm ROM when a bra providing high breast support was worn. During treadmill running, this bra also reduced the breast ROM compared with the use of a bra providing low (and less effective, according to the authors) breast support. In our study, proper breast support increased trunk rotation. This effect could be explained by participants' application of a strategy to minimize unpleasant breast oscillation when running without a bra by "squeezing" the breasts between their upper arms. This strategy likely did not mechanically restrict undesired breast motion but may have helped to create a subjective feeling of reduced motion-related discomfort. As a side effect, this self-restricting strategy could reduce trunk ROM compared with that observed when running with a sports bra. This statement is rather speculative, as changes in upper extremity motion were not analyzed in the study.

Another effect observed in this study was increased COM displacement when running with breast support. This finding is commonly interpreted as reflecting reduced stability, and thus unlikely to indicate improvement in running performance. Although this interpretation holds for the majority of postural control studies, we argue that it was an effect of increased running speed, rather than a sign of instability, in the present study.

The final important question is whether the mild negative correlation between breast and lower-body motion constitutes evidence of the effects of sports bra use on the kinematics of running. Statistically, coefficients < 0.4 do not indicate strong correlations unless the experimental condition is unfavorable and affected by factors that cannot be excluded from analysis. An example of such a factor would be the arrangement of all segments of the running body in kinematic chains, in which motions of all segments are mutually dependent. These natural mechanics of the human body dictate that increased ROM in the lower extremities and trunk generates excessive motion of the breast, which is obviously attached to the trunk. However, that was not the case in our study, as correlations between lower-body and breast motions were negative. Thus, the mild correlations, observed against all biomechanical properties of a moving body, could signify increased significance of the effect of breast support on overground running performance.

Future studies may investigate such correlation effects during longer or faster overground running, as velocity reduction, with corresponding changes in lower-body kinematics, may have been a protective mechanism to reduce discomfort during overground running with unsupported breasts in this study. This statement is rather speculative and based on the results of other works [13, 20], as the present study did not address the question of discomfort due to lack of breast support while running.

5. Conclusions and Limitations

In summary, this study showed that sports bra use alters lower-body kinematics, thereby improving overground running. Further investigation of this topic would provide a better understanding of how to enhance sports bra design, which may lead to improved sports performance, as the present study has several limitations. First, the sample of female participants was relatively homogenous, with small to medium-sized breasts; few participants had large breasts (D cup and larger). Second, the convenience sample may not be representative of the physically active female population. Third, the running trials were performed over a short distance, which may have influenced certain kinematic parameters. All of these limitations will be

addressed in future works.

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Differences in the Level of Children Gross Motor Skills Development in Silat, Taekwondo and Karate in Malaysia

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Abstract Gross Motor Skills Development plays a very important role in the field of Sports Studies. By constantly and scientifically monitoring their gross motor skills in the sports and recreational activities which they are involved in, such as martial arts, can assure and guide the development of young children motor development. Also, it is important to find out which martial arts would develop more gross motor skills of these children. This study aims to identify the level of development in children gross motor skills who are involved in martial arts sports. These sports consist of Silat, Taekwondo and Karate in Selangor. Methods: This study was an ex-post factor which involving 90 subjects (Silat = 30, Taekwondo = 30 and Karate = 30) aged from 6 to 10 years and 9 months. The independent variables of the study are the three types of martial arts that the children are practicing in (i.e., Silat, Taekwondo, and Karate). Ulrich's (2000) gross motor development test was adapted in the study to measure the level of children's motor development in martial arts for locomotor and manipulative skills. The obtained raw scores were transcribed to obtain the locomotor standard (SPL) score, manipulative standard score (SPM), locomotor equivalence score (AEL), manipulative age equality score (AEM) and Gross Motor Development Quotient (GMDQ) score (all of which are the dependent variables). The scores were analyzed using ANOVA software to compare children's mean achievement (DV) by martial arts (IV). The findings showed that there was a significant difference in mean AEM scores among martial arts [$F(2, 87) = 6.814$, $p < .05$]. For Post Hoc Test analysis, there was a significant difference in mean AEM score between Silat and Karate ($p = .02$) and between Silat and Taekwondo ($p = .007$). There was no mean difference in AEM score between Taekwondo and Karate ($p = 0.99$). There was no difference between the mean AEL score [$F(2, 87) = 0.37$, $p > .05$] and the mean GMDQ score [$F(2, 87) = 0.034$, $p > .05$] between Silat, Taekwondo and Karate. The findings showed that there is a discrepancy in the development of gross motor in the manipulative skills of children between martial arts sports. According to the findings, it shows that there is a significant increase in motor development for each child according to their sports. However, these developments are not consistent with their chronological age. The GMDQ scores show that the development of children's gross motor skills in martial arts such as Silat, Taekwondo and Karate is still low.

Keywords Gross Motor, Martial Arts, Locomotor Equality, Manipulative Age Equality, GMDQ Score

1. Introduction

Motor development is a lifelong cycle (Noramy & Kamarul Arifin, 2017; Borhanundin & Kok, 2014; Gallahue & Ozman, 2006). In particular, motor development is a gradual process whereby individuals perform from simple, irregular and unskilled motor skills to more complex, organized motor skills as they age, (Haywood and Getchell, 2005). However, motor development does not only revolve around age and physical growth. According to Gallahue and Ozman (2006), the development of gross motor also includes various aspects such as physiological systems, motor systems and nervous systems.

Motor development is divided into two parts: gross motor development and fine motor development. Gross motor development is a development of an action that involves one or a large group of muscles that are clearly visible (Lubans, 2010). Fine motor development is a development of an action that involves a small and intangible muscle group (Gallahue, 1998). The development of children's motor skills in the areas of motor

skills behavior can be seen through the skills of motor skills. The main principle in motor development is the basic motor movement, which is found in the movement using motor skills, (Farrokhi, Zareh, Karimi and Kazemnejad, 2014). Gross motor movement involves a large amount of force exerted by a group of muscles producing a particular movement or skill. These skills refer to the play patterns that are intended and divided into locomotor movements and control of objects (Gallahue, 2006).

Meanwhile, locomotor skills are physical activities that move individuals from one place to another, moving forward, backward or upward, using a variety of skills, (Borhannudin & Kok 2014). Examples of locomotive skills include walking or running, leaping and skipping. Object control skills are skills that require coordination between the body and objects in terms of sending objects or receiving objects such as hitting and catching (Borhannudin, 2014). Hardy, King, Farrel, Macniven and Howlett (2010) found that early childhood is an important phase in which every change in muscle and motor development occurs very rapidly. The development of children's gross motor skills progresses well when children are able to move around by imitating it (Yasminder Kaur & Choon Lian, 2018). The mastery of skills will be accelerated in early childhood if they are exposed in advance to the correct use of gross motor skills (Olrich, 2002; Agnes & Daniel 2009).

The developmental capacity of children's gross motor skills depends on several factors. The factors which affect them are socio-economic status, age, gender and involvement in physical activities such as recreation and sports. The development of gross motor skills for children should develop according to their chronological age. Therefore, this is a key requirement and every educator involved in the syllabus and teaching of physical activities (P.E = Physical Education) should play a major role in ensuring that the children gross motor skills are well developed as they age. According to Borhanuddin and Tan Kien Kok 2014, which quoted a statement from the National Standard of Physical Education (NASPE, 2004) stating that children's motor skills develop through involvement in sports and games. Healthy and active lifestyles during the early stages of childhood will help improve their motor development throughout the growing process. An example of a healthy and active lifestyle for children is to engage them in martial arts activities.

Martial arts is a phrase often used to describe a number of sports which involve physical contact, such as Taekwando, Judo and Karate (Burke, Al-Adawi, Lee and Audette, 2007). The skills found in martial arts include jumping, kicking and punching. These skills are fundamental skills in the development of children's gross motor skills. In addition to encouraging the development of gross motor skills, involvement in martial arts sports also enhances self-confidence, mental and physical strength and makes children more self-reliant (Borhannudin, 2014). From these studies, they propose to conduct a study on other types of martial arts or other sports to determine which sport contributes significantly to the development of children's gross motor skills. Therefore, researchers conducted research on different martial arts in this study. This study attempts to determine whether children's motor skill development is in a good condition after engaging in martial arts and differences in gross motor skills development in Silat, Karate and Taekwondo

The objectives set for this study are to assess the developmental stages of locomotor skills and object control skills (DV), by which the researchers assess: a) locomotor skill age equality scores (AELs), b) object control skill equality scores (AEMs) and assess c) children's Gross Motor Development Quotient (GMDQ) scores children involved in Taekwando, Karate and Silat (IV).

2. Methods

2.1. Design

The design of this study is structured in the form of ex-post facto because the sample or group was not randomly classified. An ex post facto research design is a method in which groups with qualities that already exist are compared on some dependent variable. Also known as "after the fact" research, an ex post facto design is considered quasi-experimental because the subjects are not randomly assigned - they are grouped based on a particular characteristic or trait. Although differing groups are analyzed and compared in regards to independent and dependent variables it is not a true experiment because it lacks random assignment. The assignment of subjects to different groups is based on whichever variable is of interest to the researchers.

The independent variables of the study are the three types of martial arts that the children are practicing in (i.e., Silat, Taekwondo, and Karate). This study utilized the purposive sampling technique, which is deemed suitable in an ex post facto study research design. The sampling was done on three particular schools in the district of Lembah Klang, Selangor, Malaysia – to which all these three schools offer the three types of martials arts (i.e., Silat, Taekwondo, and Karate) as part of the schools' co-curricular activities. In this study, the samples were classified according to the three types of martial arts and their own characteristics involving 90 subjects (Silat = 30, Taekwondo = 30 and Karate = 30) ranging in age from 6 to 10 years and 9 months. The tests performed are locomotor skills tests and object control tests. The scores were assessed according to 24 criteria of skills in gross motor development by Ulrich (2000). Through this method, researchers can also identify levels of gross motor

development (DV) in the form of locomotor standard (SPL) scores, manipulative standard scores (SPM), locomotive skill age equilibrium (AEL), manipulative skill age equilibrium (AEM) and Gross Motor Quotient scores (GMDQ) (all of which are the dependent variables). Each locomotive skill and object control skill has its own set of criteria. If the criteria was met, a score of 1 is given, and if not a score of 0 is given. The minimum score is 0, and maximum score is 48 for each participant. Researchers will analyze video recordings to obtain raw scores. All raw scores were recorded in the provided score form. The video footage obtained from the EOS 550D DSLR camera was transferred to an Acer computer and stored in a folder according to the types of sports.

2.2. Test Equipment

The child's level of motor skills and motor abilities in terms of locomotor and object control is used based on the chronological age of each subject. The TGMD-2 instrument measures 12 basic skills and is divided into six locomotor skills and six object control skills. For locomotor skills, each respondent practiced run, gallop, hop, leap, horizontal jump, and slide. For object control skills, the skills tested include striking a stationary ball, stationary dribble, catch, kick, overhand throw, and underhand roll. To perform these gross motor development tests, several types of tools were provided. Among the tools used are (1) 2 sets of Canon EOS 550D DSLR cameras, (2) 1 Accer Aspire V11 Touch computer, (3) cones or scanners to classify each skill test subset, (4) measuring tape, (5) nut., (6) rubber balls, (7) plastic bat, (8) tee batting, (9) basketball, (10) plastic balls, (11) soccer, (12) tennis balls, (13) softball and (14) TGMD-2 personal information form and test score. Test of Gross Motor Development 2 (TGMD-2) with a Cronbach's alpha value of 0.69 for 12 skill tests, 0.46 for locomotor skills and 0.64 for object control skills was used as a testing tool for the selected subject-specific subjects.

3. Findings

3.1. The Developmental Stages of AEL, AEM and GMDQ for Children Involved in Taekwando, Karate and Silat

Based on the findings, the mean and standard deviation for the overall AEL were (M = 16.17, SP = 6.845). For analysis on TAEKWONDO AEL (M = 16.9, SP = 7.586) the highest mean values were obtained, while SILAT (M = 15.37, SP = 5.816) and Karate (M = 16.23, SP = 7.157) is at a lower level. The mean and standard deviation of the overall standard for AEM were (M = 12.93, SP = 3.865). For the analysis on AEL sports (M = 14.93, SP = 4.719) the highest mean values were obtained, while TAEKWONDO (M = 11.9, SP = 2.139) and Karate (M = 11.97, SP = 3.577) is at a lower level. The mean value and overall standard deviation for GMDQ were (M = 78.6, SP = 10.549). For analysis for TAEKWONDO sports AELs (M = 79.0, SP = 10.151) having the highest mean values, while SILAT sports (M = 78.3, SP = 10.049) and karate (M = 78.5, SP = 11.714) is placed at a lower level.

Table 1. Descriptive statistics of overall scores for each martial art

Item	Sports	Mean (M)	N	Standard Deviation (SD)	*Descriptive rating*
AEL	Silat	15.37	30	5.816	Below Average
	Karate	16.23	30	7.157	Below Average
	Taekwondo	16.9	30	7.586	Below Average
	Total	16.17	90	6.845	
AEM	Silat	14.93	30	4.719	Below Average
	Karate	11.97	30	3.577	Low
	Taekwondo	11.9	30	2.139	Low
	Total	12.93	90	3.865	
GMDQ					
	Silat	78.3	30	10.049	Low
	Karate	78.5	30	11.714	Low
	Taekwondo	79	30	10.151	Low
	Total	78.6	90	10.549	

3.2. Differences in Locomotor (AEL) Scores for Children Involved in Taekwando, Karate and Silat

Based on the descriptive analysis in table 1, the mean AEL score for taekwondo is higher than the other two sports. According to table 2, there was no significant difference F (2, 87) = 0.373, p> 0.05 between mean AEL scores for Silat, Karate and Taekwondo. As no significant differences were made, group comparative analysis was not required.

Table 2. ANOVA Inference Analysis for AEL

	Sum of Squares	df	*Mean Square*	F	Sig.
Between group	35.467	2	17.733	0.373	0.69
Within group	4135.033	87	47.529		
Total	4170.5	89			

3.3. Are there any Differences in Manipulative Age (AEM) Scores for Taekwando, Karate and Silat Children?

Based on the descriptive analysis in table 1, the mean AEM score for Silat is higher than the other two sports. According to table 3, there was a significant difference in mean AEM score between Silat, Karate and Taekwondo F (2, 87) = 6.814, p <.005. Due to the significant differences that occur, group comparative analysis should be performed.

Table 3. ANOVA Inference Analysis for AEM

	Sum of Squares	df	*Mean Square*	F	Sig.
Between group	180.067	2	90.033	6.814	0.002
Within group	1149.533	87	13.213		
Total	1329.6	89			

Games-Howell Post Hoc analysis was conducted to see more comparisons between groups. Games-Howell analysis was used for homogeneity test of variance using Levene Statistic to determine significance (p = 0.010).

Table 4. Games-Howell Post hoc analysis of AEM scores

(I) sports	(J) sports	*Mean Difference (I-J)*	*Std. Error*	Sig.
Silat	Karate	2.967*	1.081	0.022
	Taekwondo	3.033*	0.946	0.007
Karate	Silat	-2.967*	1.081	0.022
	Taekwondo	0.067	0.761	0.996
Taekwondo	Silat	-3.033*	0.946	0.007
	Karate	-0.067	0.761	0.996

According to Table 4, the AEM scores for the three different martial arts groups indicate that there are significant differences between each item. High mean difference scores occurred between Silat and Taekwondo with a mean of 3.033 and a significant difference value of p = 0.007 compared to mean difference between Silat and Karate with a mean of 2.967 and a significant difference value of p = 0.022. Whereas the mean difference between karate and taekwondo was very low at 0.067 and it was found that there was no significant difference in AEM scores between Karate and Taekwondo.

3.3. Differences in the GMDQ Scores of Taekwando, Karate and Silat

Based on the descriptive analysis in table 1, the mean GMDQ score for taekwondo was highest compared to the other two sports by value (M = 79, SP = 10.151). According to table 5, there was no significant difference F (2, 87) = 0.03, p> 0.05 for GMDQ scores between Silat, Karate and Taekwondo.

Table 5. Inference analysis of GMDQ scores using Anova test

	Sum of Squares	df	Mean Square	F	sig
Between group	7.8	2	3.9	0.034	0.966
Within group	9895.8	87	113.745		
Total	9903.6	89			

4. Discussion

Human motor development is an ongoing cycle and it is an increasingly important area of academic study for those studying Physical and Health Education (CBC) and Sports Science. As a natural process in human beings, the development of gross motor skills refers to changes in the ability to move and movement is a basic or general movement as it extends over life (Payne & Larry, 2012).

Based on a study of the level of motor skill development of 90 children involved in this sport, the findings show that their level of locomotor skill development did not show significant differences. Depending on the mean SPL score, the average mean SPL score was 7.34 (minimum = 1, maximum = 11). For locomotor age (AEL), mean score was 16.17. The locomotor skills found in the TGMD-2 test are six of the 12 basic locomotor skills of running, galloping, one-leg jump, long jump, high jump and sideways. Running is a natural movement that develops from walking. According to Whitall and Getchell (1995), on average children begin to show running skills between six months and six months after they are able to work independently. The movement of the running skills will improve with age. Next is the jumping skill. Jumping exercises require children to push their bodies into the air

with the production of force from the leg muscles. Most kids can do jump skills after they master the skills or are proficient in running

After running and jumping, new movement skills such as galloping and side steps will emerge. This movement is said to be more difficult because it requires coordination throughout the body. However, based on the results of this video recording analysis, most of them could not meet the movement criteria set out in the TGMD-2 test. As an example of running skills, most of them lay flat on the entire foot on the floor and the hand-eye coordination is not working well. This may be because the movement norms of these three types of sports do not require them to do sprinting properly.

In terms of locomotor age (AEL), children in all three sports are still below average. According to Payne (2012), children can practice their skills by meeting all the criteria at the age of six and above. As for stand-up jumping skills, most children in all three sports are unable to meet the set criteria. This is because, at this age of 10, the leapfrog began to be acquired. On average, some of the criteria for each locomotive skill start at the age of six. Children in martial arts, karate and taekwondo should be above average as the ages selected in this study range from 6 years to 10 years and 9 months. This may be due to a lack of emphasis on proper locomotor skills during training sessions.

In general, once the child is able to move around without help, the hands are free to explore the environment constantly. With the change of time, experience and training, both eye and foot coordination increased dramatically. At this point, children will begin to exhibit categories of skills referred to as manipulative skills or object control. These skills include throwing, catching, kicking the ball, bouncing the ball and hitting deadly objects. Each of these skills was tested in this study. While it is clear that these elements of movement and skills are not available in martial arts, taekwondo and karate, each child should be able to perform well as it is a basic movement in manipulative gross motor skills and is listed in the Gross Motor Development Test, Ulrich (2000). For manipulative motor skill development, children begin to master all the criteria of movement starting at the age of 6 and reaching maximum mastery at 10 years old. However, the development of manipulative skills in boys occurs much earlier than in girls.

Furthermore, with regard to mastery of manipulative skills (SPM), Silat is scaled at a higher level than Taekwondo and Karate. The overall mean value for SPL is 5.47 (minimum = 2, maximum = 11). This is because Silat has more movement and object control skills than Karate and Taekwondo. For example, in Silat, they will be taught using tools such as wood, *keris*, cloth and so on. Although these tools are not used all the time, they still have experience using them. This causes Silat to have a higher level of manipulative skills than Karate and Taekwondo sports.

5. Conclusions

Engaging in sports at an early age has a lot of positive effects on children. As for gross motor skills development, children are encouraged to participate in various sports at the early age of five or six years. This is supported by Premachandran (2006) on a 4-year-old who set a 65-kilometer track record in seven hours and two minutes. The importance of sports involvement to children is to enhance locomotor and manipulative skills while also enhancing the specific skills of the sport. For example, Silat, Taekwondo and Karate have similar skills such as kicking, jumping, punching and so on. In order to master these specific skills, children must have good mastery of basic motor skills

In addition, during their involvement in sports, children are better able to interact with the environment as described in ecological perspective and dynamic systems theory approach. Good interaction between individuals, the environment and tasks will motivate good motor movement. In addition to enhancing the motor skills, it can also promote social skills, cognitive skills, muscle strength and build a positive attitude and character in children (Borhanuddin, 2014)

6. Recommendation

It is best in humanity interest that the results of this study will serve as a guide, a foundation for parents to send their children as young as five to a sports training center in particular so that it can assist the development of children's motorcycle development. This is clear because maturity and experience are fundamental principles in human motor development. In addition, it is best in our interest that schools will make martial arts a major co-curricular club similar to that of football and netball to assist with age-appropriate motor development.

The research conducted by the researcher involved only a small and not comprehensive scope of research. It is suggested that in future studies, researchers increase the number of subjects in motor development activities according to age and comparison of more sports. In addition, further studies need to be conducted on different types of individual or group sports to identify sports that have the most influence on children's motor development.

In addition, the next proposal is to enhance physical activity among school students by making martial arts sports among the major sports clubs in the curriculum. This indirectly enhances social cohesion and promotes a healthy and active body.

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The Effects of Tissue Flossing on Perceived Knee Pain and Jump Performance: A Pilot Study

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Abstract **Background:** Tissue compression and partial vascular occlusion using band flossing results in reperfusion of blood to the muscle tissue that may ultimately reduce joint pain and increase range of motion, enhancing prevention from or rehabilitation of injury. However, the extent of research examining the effect of tissue flossing in an athletic setting is currently very limited, and the effects of band flossing on knee pain and jump performance have not yet been investigated and remain unclear. **Purpose:** To investigate the effect of band flossing on perceived knee pain and vertical jump performance in recreational athletes with knee pain. **Methods:** Five young male recreational athletes with previously reported knee pain took part in this study (age 22±0.5; height 184±6.8cm; weight 79±1.5kg; BMI 23.34±1.2 kg/m2). Participants performed a number of tests pre and post intervention, with the application of a floss band on the knee joint. The experimental protocol consisted in the performance of countermovement jump (CMJ) tests (without occlusion, with occlusion, and after occlusion). Pre and Post intervention measures included a perceived knee pain -by visual analogue scale (VAS)- and CMJ performance -by force platform-. **Results:** The application of flossing bands in knee joint resulted in enhancements in all test measures pre to post intervention (10% jump height; 4.5% time in the air; 5% jump velocity; 13% jump power; 7.5% jump force). Participants reported a 3.5-point pain enhancement in AVS during performance of CMJ tests. **Conclusion:** Flossing bands caused a reduction in perceived knee pain and improved vertical jump performance in young male recreational athletes.

Keywords Floss Bands, Vascular Occlusion, Joint Pain, Countermovement Jump, Patellofemoral

1. Introduction

In recent years, the use of compressive materials has grown considerably, both for the improvement of physical performance and for health. This boom is due, to a greater extent, to the benefits provided by their use. For its correct application, different types of garments and/or compressive materials have been developed that respond to different areas and objectives.

One of the most widespread compressive materials are compressive garments. Their origin comes from the health field and it has been demonstrated that they have positive effects on the blood circulation of the extremities [1,2]. In the field of sports, it has been proven that the prolonged use of compressive garments has improved performance in different sports [3–5]. The possible explanation would be its positive effects on venous hemodynamics [6], decreased exercise-induced muscle damage [7–9], and its possible contribution to recovery [8,10–12]. There are different types of compression garments, stockings, sleeves, upper body garments (covering the torso and upper limbs completely or partially) and lower body garments (from the waist, covering the lower limbs completely or partially) [13].

Another compressive material whose use has grown exponentially in recent years in the field of strength training, are occlusion cuffs. Unlike garments, these apply a band (inflated, elastic or rigid) to the area closest to the extremities with the intention of restricting the blood flow. Strength training with blood flow restriction (BFR) has shown significant gains in hypertrophy [14–16] and muscle strength [15,17–19]. In addition, these benefits are obtained by training at low intensity (loads around 20-40% of 1RM). It is therefore a very useful method for sectors of the population that, for health reasons, do not tolerate high loads on their joints and must improve their strength and hypertrophy [17,20–22].

On the other hand, recently a new material and method has been incorporated to compress the joints by means of an elastic band called flossing or floss band [23]. This consists of the use of reusable rubber bands with the aim of compressing a muscle region or a joint. Its purpose is to

improve the range of motion (ROM), restore the mechanics of the joints and decompose the adhesive tissue of the previously injured musculature.

There is scientific evidence that supports its use to increase ROM [24–26] and pain reduction [24,27]. However, these results are not conclusive as there are other studies in which no improvement has been observed in these two variables [28,29]. Most studies have applied the flossing band to the ankle [25,26,30,31], the shoulder [29], or the wrist [24]. Only in one case has it been applied to the knee and improvements in strength were observed [32].

Concurrently, one of the most common knee problems is patellofemoral pain syndrome (PFPS), which is characterized by the presence of peripatellar or anterior knee pain [33], affecting one in four people [34,35], and also being responsible for a high percentage of knee sports injuries [36]. For that reason, it would be helpful to find a non-invasive way to improve this issue.

The effects of the flossing band on ROM, performance and knee pain are unknown, but since improvements have been seen in other joints [24,27], and other therapies similar to flossing band, such as bandaging techniques (Infrapatellar, Kinesiotape or McConnell), have been shown to help reduce painful symptoms and improve muscle function and strength [37–41], flossing band could probably also be applicable to the knee joint.

Therefore, the objective of this work is to investigate the effect of elastic bands (flossing) on perceived knee pain and vertical jump performance in amateur athletes with PFPS.

2. Materials and Methods

2.1. Participants

Five young male recreational athletes with PFPS took part in this study (age= 22.0±0.5 years; height= 184.1±6.8 cm; weight= 79.0±1.5 kg; BMI= 23.34±1.20 kg/m^2). To be eligible for this study, they all had to have been diagnosed with the PFPS for at least three months, but no known knee injury. They all had strength training experience and signed an informed consent form prior to any intervention or data collection. Candidates who could be adversely affected (cardiovascular or joint health) by the intervention in the study were excluded.

2.2. Procedure

The participants performed a pre and post test, with or without application of a floss band (Life Floss bands, Sydney, Australia) on the painful knee. Two different days (intervention and control) were used to carry out the protocol, using the application of the floss band in the first of them, and eliminating its use in the second. The aim of the separation into two days was to rule out that the application of one protocol would affect the results of the next.

On the first day (FLOSS) three series of three counter movement jumps (CMJ) were performed, with the average of the three jumps in each series. CMJ was performed from an upright position with straight legs, beginning the jump with a counter movement down to a knee angle of 90 degrees. Hands were held on the waist during the whole jump to avoid any effect of arm-swing. We used 1-minute rest between series, and 15 seconds between repetitions. 1st series: without application of floss band (PRE); 2nd series: with application of floss band (FB) (Figure 1); 3rd series: without application of floss band, after removal (POST). On the second day (CON), the same protocol was performed, but without the application of floss band: three series (S1, S2 and S3) of three CMJ with 1-minute rest between series and 15 seconds between repetitions. The same jump performance and perceived pain variables were measured on both days.

Figure 1. CMJ with floss band

2.2.1. CMJ

Each participant performed the CMJs with their hands on their waist, starting from an upright position and keeping their legs extended throughout the flight phase. Variable jump height, time in the air, jump velocity, jump power and applied force were measured using a force platform (Kistler 9287 BA, Kistler Instruments Ltd., Hook, UK).

Perceived knee pain was also measured in all three phases of the protocol. Each phase corresponds to the perceived pain at the end of each series of three CMJs. A visual analogue scale (VAS) divided into 10 equal parts (indicating 0 as no pain and 10 as unbearable pain) was used for assessment.

2.2.2. Floss Band Application

The painful knee was bandaged according to the manufacturer, surrounding it from the most proximal to the most distal area, leaving 30% of the band visible and overlapping along the joint (Figure 2). To ensure that the pressure of the band was adequate, the Kikuhime pressure measuring sensor (MediGroup, Melbourne, Australia), located between the band and the lateral condyle of the femur, was used. The average pressure was 182±38 mmHg.

Figure 2. The floss band knee bandaging technique used

2.3. Statistical Analysis

Data analysis was performed using the IBM SPSS Social Science Statistical Package, version 25.0 (SPSS Inc., Chicago, IL, USA). The sample distribution was tested using the Shapiro-Wilk test. A T-Student test was performed to check if there were significant differences. A value of $p<0.05$ was established to determine statistical significance.

3. Results

Significant differences were found in all the analysed variables regarding the performance of the vertical jump in the protocol applying the floss bands ($p<0.05$). No significant differences were found in any of the variables analysed related to the vertical jump performance in the protocol that did not apply the floss bands ($p=0.283$). Significant differences in perceived pain were found in the protocol applying the floss bands ($p<0.001$). No significant difference in perceived pain was found in the protocol that did not apply floss bands ($p=0.413$). Table 1 presents these results.

All variables were evaluated during the three series of jumps, although significant differences were only found between the first and third series. Thus, the application of the floss bands was found to significantly improve the performance of the CMJ, as well as significantly reduce the perception of pain in the knee where the floss bands were applied, but not during their application, but after their removal.

Table 1. Pre, FB and Post (or S1, S2, S3) measures (mean ± SD) and percentage of variation, in the two days of intervention

	FLOSS (mean ± SD)				CON (mean ± SD)			
	PRE	FB	POST	Δ (%)	S1	S2	S3	Δ (%)
JH (cm)	36.03±5.21	36.39±7.09	40.02±5.60	11.1±1.4*	31.69±4.45	31.46±5.12	32.61±4.73	2.9±0.8
TA (s)	0.542±0.076	0.549±0.081	0.571±0.082	5.4±0.7*	0.508±0.071	0.498±0.079	0.521±0.074	2.6±0.5
JV (m/s)	1.33±0.19	1.34±0.21	1.41±0.20	6.0±0.8*	1.25±0.18	1.24±0.21	1.28±0.18	2.4±0.4
JP (W)	3837±537	3852±539	4371±612	13.9±1.8*	3280±460	3257±441	3389±497	3.3±0.9
JF (N)	2886±404	2895±412	3121±437	8.1±1.1*	2630±368	2614±349	2697±386	2.5±0.7
AVS 1-10	4.0±0.7	3.8±0.5	0.5±0.5	-87.5±9.7**	6.0±0.7	5.5±0.8	5.2±0.5	-13.3±7.7

FLOSS= Day when floss band protocol was applied; CON= Control day in which the protocol was performed without the floss bands; PRE= Without application of floss band; FB= With application of floss band; POST= After removal of floss band; S1,S2,S3= Series 1,2,3; JH= Jump height; TA= Time in the air; JV= Jump velocity; JP= Jump power; JF= Jump force; AVS (1-10)= Analogue visual scale.

* The differences are significant (Pre vs Post $p<0.05$).

** The differences are significant (Pre vs Post $p<0.001$).

4. Discussion

The aim of this work was to identify whether the application of the floss band to the knee joint could increase the performance of the CMJ and decrease the sensation of pain in this joint.

Different studies have shown the benefits of floss bands, although the vast majority have used them on joints other than the knee. Stevenson et al. [25] showed that, by compressing the ankle joint for 2 minutes, significant improvements were achieved in dorsiflexion of this joint ($p<0.032$). Driller & Overmayer [26], also found significant improvements in ankle ROM and one-leg jumping performance ($p<0.01$). The same research group in a later work found, in agreement with the previous one, that the application of the floss bands in both ankles during 2 minutes, could improve the performance in the ROM, the CMJ and the sprint until 45 minutes after its application [30]. However, although significant differences were found in ankle ROM ($p<0.05$), both CMJ and sprint performance were not ($p>0.05$). Very similar results were obtained by Mills et al. [31], finding improvements in ankle ROM, CMJ and sprint performance, although not significant in the latter two ($p<0.05$).

Floss bands have also been applied to other joints, such as the shoulder, in order to analyse their influence on ROM and their power in the bench press movement [29]. Although no significant differences were found in any of these variables, the authors suggest that floss bands may have a greater influence on less complex joints than the shoulder. They attribute this lack of efficacy to the deficiency of the bandage to compress all the muscles involved in the movements evaluated. On the other hand, the wrist has also been analysed, in a case study based on a participant with "Kienböck disease" (aseptic avascular necrosis of the crescent carpal), who presented pain and swelling on the right wrist dorsum [24]. In this work, the influence of the floss band on pain reduction and improvement of wrist functionality in aspects of daily life, such as pain, numbness, tingling, ability to drive or work, was analysed by means of questionnaires. After 6 weeks of application of the floss band treatment (1-3 minutes of application before your rehabilitation exercises), significant improvements in both pain perception and wrist functionality were found ($p<0.05$).

Although the use of the floss band is recent, different modes of compression or bandaging have shown benefits for decades. Patellar taping, for example, showed a significant decrease in pain ($p<0.005$) and an increase in performance in the Star Excursion Balance Test in patients with PFPS [39]. Kuru et al. [41] concluded that Kinesio bands showed the same benefits as electrostimulation in patients with PFPS, in terms of pain reduction, improved ROM, strength, functional capacity and quality of life. It is relevant to mention that both works, contrary to our results, showed the benefits during the application of the band, while in the present work the improvements came after removing the floss band.

Mason et al. [37], on the other hand, also found benefits in pain reduction in patients with PFPS by means of infrapatellar taping, being applied continuously throughout the week. However, their results concluded that greater benefits are obtained when combined with quadriceps stretching and strengthening work. Similar results were evidenced by Paoloni et al. [40], where they suggested that a short period (14 days) of patellar taping and a subsequent exercise program was a good means of controlling long-term pain in participants with PFPS associated with muscle dysfunction.

Although it is complicated to allude to the physiological or mechanical mechanisms that could have favoured the changes described, it seems that our results are in the same direction as other previous work that has used this type of implement or some similar ones. Therefore, it is suggested that future research will be able to identify what these mechanisms are, as well as to provide more evidence and clarity to joint compression by means of floss bands.

5. Practical Applications

Other studies have shown the importance of good ankle dorsiflexion in shock absorption in the lower extremities when landing a jump [42], thus justifying the use, prior to exercise, of floss bands on the ankle [30]. Therefore, the previous results, as well as those obtained in this study suggest that there could be powerful and useful practical applications, considering the use of floss bands during the warm-up prior to training, or even competition. This would be a good method to reduce pain produced by PFPS, as well as to increase performance in vertical jumping. Any sport or physical activity in which vertical jumping is a performance factor could benefit greatly from this type of technique, although future research should establish which protocol produces the greatest gains in these variables.

6. Conclusions

The present study adds useful and interesting information to the novel field of floss bands, in relation to the reduction of knee pain in participants with PFPS and the increase in CMJ performance. Both variables have been improved after the application of these bands and their subsequent removal. These preliminary results can have a relevant impact in the sports setting, both recreational and competitive.

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Psychological Resilience and Violence Tendency Levels of High School Adolescents Who Doing Team and Individual Sports

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Abstract This research was conducted to examine the psychological resilience and violence tendency levels of adolescents who are dealing with team and individual sports. In total, 225 volunteer athletes (104 females and 121 males), who were in the 14-18 age group, participated in this study. The data were collected through the violence tendency scale and the psychological resilience scale form. According to the results of the research, it was observed that there were similarities in the psychological resilience and violence tendency levels of male and female athletes concerning the gender and the sports experience variables. It was concluded that the violence tendency levels of the adolescents dealing with team sports were higher compared to the ones dealing with individual sports; the violence tendency levels of the athletes playing in clubs were lower compared to the athletes without a license and playing in school teams, and the psychological resilience levels of the first group were higher than the second group. Additionally, it was concluded that there was a negative, linear, and low-level significant relationship between the violence tendency levels and psychological resilience levels of the athletes in the research group.

Keywords Violence Tendency, Psychological Resilience, Sports, Adolescent

1. Introduction

Within the lifetime of individuals, it is possible to have social, psychological, and economic problems at various levels. These problems are not only for adults but also for the adolescents. Adolescence has been described as the period in life when an individual is no longer a child, but not yet an adult. It is a period in which an individual undergoes enormous psychological and physical changes. In addition, the adolescent experiences changes in social expectations and perceptions. Physical growth and development are accompanied by sexual maturation, often leading to intimate relationships. The individual's capability for abstract and critical thought also develops, along with a sense of self-awareness when social expectations require emotional maturity. It is important to keep this in mind for a more complete understanding of the behaviours of adolescents as you read through this handout [1].

International studies report that adolescents show more commonly behavioral problems [2]. However, while some adolescents can have difficulties in coping with these problems, some others can overcome these problems without being affected, or they can adapt to the situation and recover more quickly. The most fundamental factor that is effective in the adaptation process is the psychological resilience [3], which is a concept requiring the efforts of individuals, time, and continuity.

Psychological resilience is a broad and conceptual subject, which is the process of eliminating negative thoughts and ensuring positive adaptation instead [4], and regaining power against adverse events rather than being unharmed in the face of a simple stress [5]. Among the factors that increase psychological resilience are the teachers, group of friends, neighbors, and other relatives, who are helping individuals to overcome the difficulties [6], as well as the trainers and physical education teachers, who are always in an interaction with athletes during their sportive activities. In fact, physical education and sports affect human life with different motives from many different genres, revealing their moods [7]. Successes and failures in the development processes of young individuals, excessive intensive trainings and difficulties in struggle, mood changes such as stress and anxiety, and adaptation processes to overcome these changes, all of which are involved in sporting activities, are becoming important for

trainers, educators, and parents. Sportive activities are the environments, where violence tendency can arise sometimes as learned behaviors, there is an intense will to fight and win, and irritations may be observed along with the frustrations.

The subject of violence is one of the concepts that is quite difficult to identify [8]. This is due to the fact that violence feeds on human thinking, it has versatile dimensions, and violence has a history as old as humanity. Therefore, while, as a phenomenon, through discussing and examining the violence concerning its sources, motives, dimensions, and emergence forms, it is not easy to define and classify a standard violence that is acceptable to any community at any time [9].

Violence can be defined as the form of aggression, in which negative emotions such as hatred, hate, and hostility gain more efficiency in an individual. The World Health Organization (WHO) defines the violence as "deliberate threat or use of physical force ending up with injury, death, psychological damage, frustration, or deprivation against another individual or a group or community". Violent behavior differs from person to person, based on its direction, severity, or type [10]. Considering that an individual applies violence while another individual doesn't in similar circumstances, it can be suggested that personal traits are effective in the violence tendency [11]. As per the violence tendency, it consists of violence-related emotions, thoughts, and behaviors of individuals. This concept is not limited to the violent behaviors of individuals; justifying the use of violence in any case is also a violence tendency as much as applying violence [12].

When the literature is examined, it is observed that the factors affecting the violence are classified in five basic categories. These are personal factors (personality disorder, impulsivity and hyperactivity, psychiatric disorders, aggression, and substance-use), family factors (domestic violence, child abuse and rejection, conflicts and poor family ties) [11], school factors (anti-social group of friends, low school loyalty, academic failure, large school, gang groups, isolation, peer group involving peer rejection and bullying), and social and environmental situational factors (power, images of violence in the media, easy access to weapons, biases against gender roles, and cultural norms) [13].

When the previous studies in this subject in the literature were examined, it was observed that generally the relationships were revealed between the psychological resilience and anxiety [14], depression [15], stress [16], life satisfaction [17], mental health [18], social support perception [19] and motivation in sports [20]. However, previous researches have not been specifically evaluated together the relationship between the psychological resilience and violence tendency on adolescent athletes. Therefore, we believe that our research contributes to general knowledge on this topic.

1.1. Research Goal

In the present study, it is aimed to determine the relationship between the psychological resilience levels and violence tendency levels of adolescent individuals, who are dealing with sports, and how it is shaped according to the addressed variables. Thus, by understanding how the adolescent athletes succeed, who have to cope with adverse circumstances of life and risky situations such as violence tendency and psychological bad-mood, and by understanding how they could stand as enduring individuals against all these adverse conditions threatening their healthy developments, will light the way for further studies on other children and young individuals under similar risks. Similar research could target improvements in resilience and cope with violence tendency amongst athletes as well.

2. Materials and Methods

In the study; since the relationships between dependent and independent variables were examined, the relational screening model was used.

2.1. Sample Group

The population of the study is Kahramanmaras and the sample group is limited to Kahramanmaras. The sample group was determined by convenience sampling method, whose sample group was comprised of 225 volunteer athletes (121 males and 104 females) in the 14-18 age group. The mean age of female is 15±1.25 and the mean age of male is 15±2.14. The athletes were adolescent individuals who were dealing with team sports (football (n=30), volleyball (n=32), basketball (n=29)) and individual sports (wrestling (n=27), boxing (n=20), athletics (n=26), tennis (n=28), taekwondo (n=33)).

2.2. Data Collection

The legal permissions were obtained from the ethics committee before starting the research. The data were collected through the personal information forms developed by the researchers, through the violence tendency scale and psychological resilience scale form. The scale forms were distributed to athletes at rest, where they train. The same procedure was applied for each athlete in different sports branches. Filling the scale forms took approximately 12 minutes for each athlete.

2.2.1. Violence Tendency Scale

The scale was developed, to be used in a research titled "Aggression and violence tendency levels of students at the secondary education level" on behalf of the Ministry of National Education. Subsequently, it was redesigned in accordance with its original form and its content validity

was verified [21]. The reliability coefficient of the Violence tendency scale was calculated as .78 and .87 in two different times. As the conclusion of the Split Half test, the 1st semi Alpha value was determined as .74, the 2nd semi Alpha value was determined as .81, and the Spearman-Brown test result for the whole was determined as .86 [22]. There are five levels at the violence tendency scale as "I strongly agree", "I agree", "Neutral", "I disagree", and "I strongly disagree". These levels have certain scores as +1, +2, +3, +4, and +5. Thus, the highest possible score to gain from this scale is 20x5=100 points, and the lowest is 20 x 1=20 points. Having (arithmetically) a high score demonstrates high tendency to violence, and having lower scores demonstrates lower level of tendency to violence. Cronbach's Alpha value was founded as 0.88 in this research.

2.2.2. Psychological Resilience Scale

The 28-item original form of the scale, which was developed based on the data collected from eleven different countries, is comprised of three subscales and eight sub-dimensions. The scale was developed from a socio-ecological standpoint, using qualitative and quantitative methods [23]. Short form of the scale was developed by Liebenberg, Ungar and LeBlanc [24], and a 12-item structure was obtained. Three iterations of an Exploratory Factor Analysis were conducted on data from the first sample of youth to identify items for inclusion in the CYRM-12. In the third analysis, a varimax rotated factor analysis of the 12 items resulted in a four-factor solution, with 10 of the items loading well. Reliability of this grouping of questions is satisfactory (α=0.754). Confirmatory factor analysis was then conducted on the second sample of youth. A satisfactory fit was obtained (χ^2 (51, N=1540) = 255.419, p=0.0001; Adjusted Goodness of Fit Index = 0.960; Comparative Fit Index = 0.957; Root Mean Square Error of Approximation = 0.050). Cronbach's Alpha for the 12 items was also satisfactory (α=0.840). The scale, whose Turkish reliability and validity tests were conducted by Arslan [25]. The exploratory and confirmatory factor analysis results indicated that a total of 51.28 % the variance was accounted for by a factor, was a five point likert scale graded between "It definitely defines me (5)" and "It definitely doesn't define me (1)". Short form (12-item) was used in this research. The internal consistency coefficient of the scale was determined as 0.91. Higher scores demonstrate higher level of psychological resilience. Cronbach's Alpha value was founded as 0.89 in this research.

2.2.3. Analyzing of Data

The data obtained in the research were analyzed through the SPSS 21 package program. Before conducting the statistical analyses, it was tested through Kolmogorov Smirnov and Levene tests whether the distribution of the data was normal. It was determined that it was not normally distributed for some variables. The t-test was used in the paired comparisons of the independent variables of the parametric data. The paired comparisons of non-parametric data variables were employed through the Mann Whitney U test, while the multiple group comparisons were analyzed through the Kruskal Wallis tests. Whether there was a relationship between the violence tendency and psychological resilience, in other words, the dependent variable was tested through the Spearman correlation test. The significance levels of the results were accepted as $p<0.05$.

3. Findings

The data obtained from the sample group were analyzed through proper test methods and presented in the following tables.

Table 1. Analysis results of the sample group concerning the gender variable (t-test)

	Gender	N	Mean	SD	t	Sig.
Violence tendency	Male	121	55.90	11.36	1.133	.258
	Female	104	54.15	11.82		
Psychological resilience	Male	121	49.00	9.19	-1.378	.170
	Female	104	50.49	6.45		

According to the Table 1, it was determined that there was statistically no significant difference in the violence tendency and psychological resilience levels of the sample group concerning the *gender* variable.

Table 2. Analysis results of the sample group concerning the sports branch variable (t-test)

	Sports branch	N	Mean	SD	t	Sig.
Violence tendency	Individual sports (wrestling-boxing-athletics-tennis-taekwondo)	77	52.92	11.97	-2.045	.042*
	Team sports (football-volleyball-basketball)	148	56.22	11.25		
Psychological resilience	Individual sports (wrestling-boxing-athletics-tennis-taekwondo)	77	49.63	7.69	-.076	.939
	Team sports (football-volleyball-basketball)	148	49.72	8.27		

*p<0.05

According to the Table 2, it was determined that there were statistically significant differences in the violence tendency levels of the sample group concerning the *sports branch* variable (t=-2.045; p<0.05), while there was no difference concerning the psychological resilience levels (t=-.076; p>0.05).

Table 3. Analysis results of the sample group concerning the sports experience variable (Kruskal Wallis)

	Sports experience	N	Mean	SD	X^2	Sig.
Violence tendency	1-3 Years	167	55.51	11.65	2.579	.275
	4-6 Years	36	52.58	10.86		
	7 +	22	56.04	12.20		
Psychological resilience	1-3 Years	167	50.04	7.90	2.149	.341
	4-6 Years	36	49.88	7.32		
	7 +	22	46.68	9.96		

According to the Table 3, it was determined that there was statistically no significant difference in the violence tendency and psychological resilience levels of the sample group concerning the *sports experience* variable.

Table 4. Analysis results of the sample group concerning the being an athlete variable (Kruskal Wallis)

	Being an athlete	N	Mean	SD	X^2	Sig.	Diff. U test
Violence tendency	1.School team	48	57.64	12.70	12.185	.016*	2<1,4
	2.Club athlete	12	46.58	12.62			
	3. Licensed athlete	26	53.92	11.05			
	4. No license	35	59.34	10.65			
	5.Other	104	53.76	10.70			
Psychological resilience	1.School team	48	50.68	9.31	12.907	.012*	2>3,4,5
	2.Club athlete	12	54.50	5.26			
	3. Licensed athlete	26	47.38	7.40			
	4. No license	35	48.88	9.24			
	5.Other	104	49.52	7.24			

*p<0.05

According to the Table 4, it was determined that there were statistically significant differences in the violence tendency levels (X^2=12.185; p<0.05) and psychological resilience levels (X^2=12.907; p<0.05) of the sample group concerning the *being an athlete* variable. In the test applied to determine the source of the difference, it was determined that this difference aroused from the club athletes.

Table 5. Analysis results of the sample group concerning the friendship relations variable (Kruskal Wallis)

	Friendship relations	N	Mean	SD	X^2	Sig.	Diff. U test
Violence tendency	1. Bad	8	53.87	9.29	.962	.810	
	2. Medium	21	56.33	11.65			
	3. Good	69	55.73	11.66			
	4. Very good	127	54.62	11.75			
Psychological resilience	1. Bad	8	44.87	7.23	15.642	.001*	1<3,4
	2. Medium	21	46.33	6.87			
	3. Good	69	49.24	7.43			
	4. Very good	127	50.79	8.40			

*p<0.05

According to the Table 5, it was determined that there was statistically no significant difference in the violence tendency levels, while there were statistically significant differences in psychological resilience levels (X^2=15.642; p<0.05) of the sample group concerning the *friendship relations* variable. In the test applied to determine the source of the difference, it was determined that this difference aroused from the group considering the friendship relations negative.

Table 6. Analysis results of the sample group concerning the sports motivator variable (Kruskal Wallis)

	Sports motivator	N	Mean	SD	X^2	Sig.	Diff. U test
Violence tendency	1.Physical education teacher	97	55.04	11.25	14.887	.005*	3<1,2,4,5
	2. My friends	34	57.20	10.29			
	3. My family	32	48.81	10.14			
	4. Sample athletes	39	56.23	12.55			
	5. Television - internet	23	59.04	12.49			
Psychological resilience	1.Physical education teacher	97	49.77	8.23	2.470	.650	
	2. My friends	34	47.97	9.00			
	3. My family	32	49.59	8.96			
	4. Sample athletes	39	51.02	6.63			
	5. Television - internet	23	49.78	6.81			

*p<0.05

According to the Table 6, it was determined that there were statistically significant differences in the violence tendency levels in favor of the ones mentioned “my family” (X^2=14.887; p<0.05), while there were statistically no significant differences in psychological resilience levels (X^2=2.470; p>0.05) of the sample group concerning the *sports motivator* variable.

Table 7. Analysis results of the sample group concerning the reason behind sports variable (Kruskal Wallis)

	Reason behind sports	N	Mean	SD	X^2	Sig.	Diff. U test
Violence tendency	1. Being Healthy	128	53.71	11.70	10.359	.035*	4>1,2
	2.Obtaining a profession	15	50.80	7.45			
	3. To be champion	17	55.17	12.31			
	4. Being Famous	10	61.80	9.75			
	5.Other	55	57.49	11.25			
Psychological resilience	1. Being Healthy	128	50.76	7.63	5.755	.218	
	2.Obtaining a profession	15	47.86	9.54			
	3. To be champion	17	47.29	10.61			
	4. Being Famous	10	48.70	7.57			
	5.Other	55	48.61	7.67			

*p<0.05

According to the Table 7, it was determined that there were statistically significant differences in the violence tendency levels (X^2=10.359; p<0.05), while there was no difference in psychological resilience levels (X^2=5.755; p>0.05) of the sample group concerning the *reason behind sports* variable. In the test applied to determine the source of the difference, it was determined that this difference aroused from the group, who mentioned that they do sports for becoming famous.

Table 8. Analysis results of the sample group concerning the father attitude variable (Kruskal Wallis)

	Father attitude	N	Mean	SD	X2	Sig.	Diff. U test
Violence tendency	1. Protective	103	54.94	10.41	4.188	.007*	2>1,3,4
	2. Authoritarian	33	60.63	11.46			
	3. Democratic	29	54.24	11.61			
	4. Affectionate	60	52.03	12.31			
Psychological resilience	1. Protective	103	50.44	7.96	5.742	.001*	2<1,3,4
	2. Authoritarian	33	44.84	9.14			
	3. Democratic	29	48.79	5.30			
	4. Affectionate	60	51.50	7.78			

*p<0.05

According to the Table 8, it was determined that there were statistically significant differences in the violence tendency levels (X^2=4.188; p<0.05) and psychological resilience levels (X^2=5.742; p<0.05) of the sample group concerning the *father attitude* variable. In the test applied to determine the source of the difference, it was determined that this difference aroused from the group, whose father attitude was authoritarian.

Table 9. Analysis results of the sample group concerning the mother attitude variable (Kruskal Wallis)

	Mother attitude	N	Mean	SD	X^2	Sig.
Violence tendency	1. Protective	76	55.22	11.71	2.653	.448
	2. Authoritarian	21	58.57	11.38		
	3. Democratic	18	53.22	9.44		
	4. Affectionate	110	54.27	11.65		
Psychological resilience	1. Protective	76	49.28	7.74	1.696	.638
	2. Authoritarian	21	48.33	8.86		
	3. Democratic	18	50.27	6.40		
	4. Affectionate	110	50.13	8.40		

According to the Table 9, it was determined that there was statistically no significant difference in the violence tendency and psychological resilience levels of the sample group concerning the *mother attitude* variable.

Table 10. Correlation analysis results of the sample group concerning their violence tendency and psychological resilience levels

			1	2
Spearman's rho	Violence tendency	Correlation Coefficient	1.000	-.219*
		Sig. (2-tailed)	.	.001
		N	225	225
	Psychological resilience	Correlation Coefficient	-.219*	1.000
		Sig. (2-tailed)	.001	.
		N	225	225

*p<0.05

According to the Table 10, it was determined that there was a low-level, negative, and linear correlation between the average scores of the violence tendency and psychological resilience levels of the sample group, and it was also determined that this relation was statistically significant (r= -.219; p<0.05). Accordingly, it was observed that the higher the violence tendency level of the sample group, accordingly, the lower their psychological resilience levels, in other words, as their psychological resilience levels increased, their violence tendency levels decreased.

4. Discussion

The results of the study, which examined the psychological resilience and violence tendency levels of the adolescent athletes dealing with either team or individual sports, are evaluated in line with the findings of the literature. According to this;

Although it was determined that, concerning the gender variable, the average violence tendency levels of the females in the sample group were relatively lower and their average psychological resilience levels were higher, it was determined that this difference was statistically not significant (Table 1). In the literature, in some previous studies conducted on the adolescent students, it was determined that the psychological resilience scores of students were statistically significant in favor of female students [26]. Similarly, some other previous studies concluded that the psychological resilience levels of the primary school 8th grader female students were higher compared to the males [27]. This result was explained by that females have responsibilities starting from early ages in Turkish culture, with high social expectations from them, which urge the females to cope with more problems. Additionally, there are previous studies conducted abroad demonstrating that males had higher violence tendency levels [28-30]. In a study conducted on male adolescents by Lopez and Emmer [31], it was observed that the sense of "masculinity" triggers violence in both physical-defensive fights and in gang-crimes. According to Thomas and Smith [32], it was observed that male students have higher levels of violence tendency and more open to provocations compared to the female students. It was reported that female students have more implicit types of violence rather than clear show of brute force. The research conducted by Rahmati and Naimikia [33] indicated that there is no significant difference between male and female athletes concerning the psychological resilience. This result supports the findings of our study. Additionally, composing the sample group only from individuals dealing with sports may also have an effect on revealing similar personal properties and creating no difference.

While it was determined that there was a statistically significant difference concerning the sports branch variable in the violence tendency levels, there was statistically no significant difference in the psychological resilience levels (Table 2), and there was statistically no significant difference concerning the sports experience among the dependent variables (Table 3).

Various previous research findings in the literature demonstrate that participation in sports has positive effects on psychological structure [34-37]. In a study conducted by Salar, Hekim and Tokgöz [38], it was aimed to examine the psychological characteristics of the athletes who are dealing with team and individual sports in the 15-18 age group. It was determined that individuals who regularly do sports at least 3-4 days a week are feeling emotionally very well. In the same study, the individuals dealing with both team and individual sports are determined to have a similar level of emotional wellness, and according to this result, it was determined that participation in both team and individual sports is useful in development of psychological health of young individuals. Because despite stressful environments, psychological resilience, which has a protective role, involves a process that can be learned [39]. In addition, the violence tendency level in team athletes was detected high. Violence tendency behavior is emerged through the influence of a large number of variables. Family behaviors [40] and watching violent films [12] might have a negative impact on aggression, and violence tendencies, while it is reported that people doing sports have more vibrant, hardworking and environmentally compatible personality features, and their psychological resilience increases [41-43].

It was observed that there were statistically significant differences in favor of the club athletes in the sample group concerning the being an athlete variable in violence tendency and psychological resilience levels (Table 4). Athletes in the sports club can have more training and competition experiences. In this process, they are subjected to difficulties in both physical and psychological terms. This increased experience also ensures the increase in their physical and psychological resilience, contributing to disciplining their violence tendency levels. In previous studies, it was suggested that psychological resilience is a process that changes over time [44] and this process increases through sports. In another study, it was determined that as the physical activity increased, psychological resilience increased as well [45]; in another research conducted on secondary education students, it was revealed that participation in sport increased psychological resilience [41]. In addition, findings demonstrating that having a license increases the violence tendency levels were reached [46].

It was determined that there was statistically no significant difference in the violence tendency levels of the sample group concerning the friendship relations variable, while there were statistically significant differences in psychological resilience levels in favor of the participants considering the friendship relations as “well” and “very

well" (Table 5). Particularly during the adolescence, individuals can experience different emotional changes while continuing their search for self. In this process, in case of a problem, positive friendship relations can help move away the negative situation by providing psychological support. This can create a positive effect on their resilience while ensuring their psychological relief. Furthermore, research findings indicated that social contribution, career goals, patience, self-confidence, desire for learning, grit, spirituality, financial situation, host society support, family members support are protective factors against risks [47]. Koç Yıldırım et al., [26] emphasize that positive peer relationships have a positive effect on psychological resilience in addition to school support especially during adolescence.

In the study, it was determined that the violence tendency levels of the participants who were motivated for sports by their families were statistically significantly lower than those in other groups (Table 6). On the other hand, it was observed that the violence tendency levels of the ones, whose father attitudes were defined as authoritarian, were higher, whereas their psychological resilience levels were lower; as per the mother attitude, it was observed that this was not an influential factor (Table 8 and Table 9). In the literature, concerning the violence tendency, it was reported that the individuals, who experienced severe conflict in the family and have divorced parents, transfer the violence into their lives or doing sports for long years do not protect the athlete from violence, which settles into the characteristics of the personality [48]. A remarkable finding of this study was that the father attitude is effective on the violence tendency and psychological resilience of adolescents, while the mother attitude does not affect. At this point, the effect of fathers on children is an issue that should not be ignored. Although the healthy family relationship supports identity formation and psychological resilience [49], the obtained result demonstrates that children are positively or negatively influenced from the attitudes of their fathers.

In the study, the violence tendency levels of the group, who were doing sports for being famous, were higher compared to those, who were doing sports for being healthy or acquiring a profession; however, their psychological resilience levels were similar (Table 7). In recent years, sports have changed its way of application and have gained new meanings with different expressions. The aggression characteristic of an individual is transformed into peace-based relaxation through sports and it provides an appropriate competition medium for controlling instinctive aggression [50]. According to psychologists, what expected from participating in sports is to strengthen and popularize an individual's values to be future forms of behavior, and to find ways to solve the difficulties faced in one's life [51]. In addition, it is important that organizing sports activities in schools suitable for students' interests, wishes, and skills will both protect mental health and prevent unwanted behaviors. However, it is observed that the violence tendency is somewhat more complex and has a structure that is affected by numerous variables. Evaluating the previous studies, it is seen that there are both views and observations that the individuals regularly doing sports are less aggressive and have lower levels of violence tendency, as well as others demonstrating that there is no significant relationship between sports and aggression [48]. In the previous research, it was even demonstrated that the ones, who are highly watching heroic or violent movies, have higher violence tendency levels [12], which prove that there are numerous variables complicating an interpretation about the relation between the violence tendencies and doing sports. However, it is a fact that sports provide a positive contribution to the levels of psychological resilience [38] and has a positive effect on psychological structure.

Research findings demonstrated that there is a low-level and negative linear correlation between the violence tendency and psychological resilience (Table 10). These findings demonstrate that as the psychological resilience levels of the sample group increase, their violence tendency levels decrease. Participation in physical education activities and sport events has a number of positive effects on the psychological and mental structures of people [52]. Besides, it is known that participation in sport events strengthens people to cope with the problems they face in their professional lives, and it has eliminated the pessimistic psychological structure that arises from the unintended and monotone life conditions [53]. According to Şahin, Yetim and Çelik [54], since participation in physical activities and sports increases the physical endurance, it develops the strength of people to struggle against the difficulties. In the previous studies, it was demonstrated that it is associated with psychological structures such as depression, anxiety, and stress that can adversely influence the violence tendency [14-16, 55].

5. Conclusions

As the conclusion, in this study, in which the relationship was examined between the psychological resilience and violence tendency levels of individuals dealing with team and individual sports, it was concluded that, according to the gender and sports experience variables, the violence tendency and psychological resilience levels of the male and female athletes were similar; the violence tendency levels of adolescents dealing with team sports were higher; the violence tendency levels of the club athletes were lower and their psychological resilience levels were higher; there was a low-level, negative, and linear significant relationship between the violence tendency levels and psychological resilience levels of the sample group.

Since the impact of violence, particularly on the children

at developmental ages, has a vital importance concerning violence in the society, it is significant that parents, educators, trainers, and physical education teachers should adopt proper approaches for supporting their students and athletes in stress, emotional changes, overcoming problems, and compliance problems.

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