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The Effect of Knee Brace and Armband Use on Motoric Performance in Volleyball: From Body Protection to Performance in the Context of the Skills Framework

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Abstract

This study aims to investigate the effects of knee pad and arm sleeve use on the motor performance of female volleyball players competing in school league categories. The study employed a one-group pretest–posttest experimental design and included 133 voluntary female volleyball players. Participants' motor performance values, such as flexibility, balance, vertical jump, speed, agility, and aerobic endurance, were measured before and after the use of knee pads and arm sleeves. The results showed that the use of knee pads and arm sleeves led to statistically significant decreases in motor performance variables, particularly those evaluated within the scope of field skills ($p < 0.05$), including flexibility, balance, speed, agility, and aerobic endurance. These decreases may be related to the restriction of joint mobility or proprioceptive interference caused by the equipment. It illustrates that protective gear can restrict athletes' motor abilities and underscores the necessity of educating athletes on equipment selection and utilization. Furthermore, the study contributes to understanding the relationship between the athlete's game and technical knowledge and equipment use within the framework of conceptual skills and sheds light on the development of ergonomic designs. This study is significant for comprehending the influence of knee pads and arm sleeves on volleyball performance and for providing a comprehensive strategy for athlete development.

Keywords: Protective equipment, youth athletes, motor performance, volleyball.

Özet

Voleybolda Dizlik ve Kolluk Kullanımının Motor Performansa Etkisi: Beceriler Çerçevesi Bağlamında Vücudun Korumasından Performansa

Bu çalışma, okul ligi kategorilerinde mücadele eden kız voleybolcuların dizlik ve kolluk kullanımının fiziksel ve motor performanslarına etkisini araştırmayı amaçlamaktadır. Çalışma, tek gruplu ön test-son test deneysel tasarımını kullanmış ve 133 gönüllü kadın voleybol oyuncusunu kapsamıştır. Katılımcıların esneklik, denge, dikey sıçrama, hız, çeviklik ve aerobik dayanıklılık gibi motor performans değerleri, dizlik ve kol kollukları kullanımından önce ve sonra ölçülmüştür. Sonuçlar, dizlik ve kol manşetlerinin kullanımının, özellikle esneklik, denge, hız, çeviklik ve aerobik dayanıklılık gibi saha becerileri kapsamında değerlendirilen motor performans değişkenlerinde istatistiksel olarak anlamlı düşüşlere yol açtığını göstermiştir ($p < 0,05$). Bu düşüşler, ekipmanın neden olduğu eklem hareketliliğinin kısıtlanması veya proprioseptif girişimle ilişkili olabilir. Koruyucu ekipmanların sporcuların motor becerilerini sınırlayabileceğini göstermekte ve sporcular arasında ekipman seçimi ve kullanımı konusunda farkındalığın artırılmasının önemini vurgulamaktadır. Ayrıca, bu çalışma, kavramsal beceriler çerçevesinde sporcunun oyunu ve teknik bilgisi ile ekipman kullanımı arasındaki ilişkiyi anlamaya katkıda bulunmakta ve ergonomik tasarımların geliştirilmesine ışık tutmaktadır. Bu çalışma, dizliklerin ve kol manşetlerinin voleybol performansına etkisini anlamak ve sporcu gelişimi için kapsamlı bir strateji sağlamak açısından önemlidir.

Anahtar Kelimeler: Koruyucu ekipman, genç sporcular, motorik performans, voleybol.

INTRODUCTION

Volleyball is a high-speed, dynamic team sport characterized by continuous player movement, rapid decision-making, and quick reaction skills (42). The game involves complex motor patterns such as sudden jumps, directional changes, leaps, falls, and ground contact. In this respect, volleyball is a demanding sport that requires not only physical but also mental endurance and necessitates the integrated use of motoric qualities such as coordination, balance, agility, and strength (7, 40). In this discipline, athletes' physical performance depends not only on their technical knowledge and skills but also significantly on the protective measures they employ against physical risks encountered on the court (2). Protective equipment frequently used by volleyball players—such as knee pads and arm sleeves—is primarily intended to enhance physical safety. However, researchers believe that these protective items may also positively or negatively impact overall athletic performance (13, 43). Despite this, scientific studies aiming to understand the impact of these protective items on motor performance remain limited (26). This indicates a significant gap in the current body of research.

In studies involving knee pads and arm sleeves, the focus has primarily been on the types, causes, and recovery processes of sports-related injuries (14, 25, 41, 44). The effectiveness of protective equipment, on the other hand, has often been based on anecdotal observations or athlete preferences rather than empirical evidence (33, 45). Particularly, the limited number of studies examining the effects of knee pads and arm sleeves on motor skills—such as balance, agility, jumping, and reaction time—in a comprehensive manner has hindered the accumulation of scientific knowledge in this area. This gap in the literature clearly underscores the originality and necessity of the present study.

The central hypothesis of this research is that the use of protective equipment not only helps prevent injuries but also has the potential to enhance athletic performance. Knee pads are designed to reduce the impact on the knee joint during physical contact, while arm sleeves are often used to retain muscle warmth, provide light compression, and serve aesthetic purposes (15, 33). Considering the physical demands of volleyball, the effects of such equipment on athletes' endurance, speed, agility, and overall performance constitute a highly relevant and valuable field of research.

In this context, the role of protective gear—particularly in injury prevention—holds a prominent place in the literature. Injury prevention in volleyball has been a topic of considerable interest among researchers (17, 24). Although there are few direct studies addressing the impact of arm sleeves and knee pads on athletic performance, the role of knee supports in injury rehabilitation and prevention has been extensively studied (39, 48). The primary function of such orthopedic supports is to provide protection by limiting valgus motion in the knee during lateral forces—ideally without restricting athletic performance (20, 27, 39). However, existing research on the effectiveness of knee supports in injury prevention has produced mixed findings.

Some studies have reported positive effects in reducing injury risk (27, 39), while others have found no significant impact (15, 34, 48). Moreover, many of these studies have been conducted with healthy or previously injured athletes, recreational participants, or individuals not actively engaged in competitive sports (16, 20; 39). This raises concerns about whether the unique structure and performance demands of competitive sports like volleyball—where knee pads are commonly used—are adequately reflected in the current body of research. Indeed, knee pads and arm sleeves are routinely used by many volleyball players, and investigating whether this equipment has a significant effect on motor performance is critical—not only for optimizing athletic output but also for informing equipment choices. Accordingly, this study aims to determine the effects of knee pad use on lower extremity explosive power, linear speed, agility, endurance, balance, and flexibility among female volleyball players who actively compete in inter-school tournaments in the junior, intermediate, and senior categories.

METHOD

Research Model

This study employed the "one-group pretest-posttest design," which is one of the experimental designs involving a single group, where data are collected through multiple pretests and posttests (12). In this design, the effect of the experimental treatment is tested on a single group. Measurements related to the dependent variable are obtained from the same participants using the same instruments both before (pretest) and after (posttest) the intervention (10).

To examine the role of knee pad and arm sleeve use on participants' motor performance levels, a one-group pretest-posttest research model, as illustrated in Table 1, was developed for the study.

Table 1. Research Model

Group	Pre-test	Process	Post-test
G	O_1	Use of Equipment (Knee Pads and Arm Sleeves)	O_2

Study Group / Population and Sample

The study population consisted of 279 female athletes who actively competed in inter-school volleyball tournaments (junior, intermediate, and senior categories) held in Rize province during the 2024–2025 academic year (37). From this population, 133 athletes who volunteered to participate and represented the same competition categories formed the study sample. The sample size was determined a priori using G*Power 3.1.9.7 software. Assuming a medium effect size (f = 0.25), an alpha level of 0.05, and a statistical power of 0.80, the minimum required sample size was calculated as 128 participants. Accordingly, the obtained sample (n = 133) was deemed sufficient for the analysis. A simple random sampling method was employed in the study. This approach ensures that each unit in the population has an equal and independent chance of being selected for the sample. In other words, all individuals in the population have an equal opportunity to be included in the study, and the selection of one individual does not influence the likelihood of others being selected (10, 22).

Data Collection Tools

In the study, data were collected using a personal information form developed by the researchers, along with a series of motor performance tests administered to the athletes.

Sit-and-Reach Test: The flexibility levels of the volunteer athletes participating in the study were assessed using the Sit-and-Reach Test. The dimensions of the testing box were standardized as follows: length 35 cm, width 45 cm, height 32 cm, top surface length 55 cm, and top surface width 45 cm. Participants were asked to sit barefoot on the testing bench and reach forward without bending their knees. They extended their arms forward as far as possible in front of their bodies, bending from the waist and hip joints, and were required to hold the furthest position reached for 1–2 seconds without bouncing forward or backward. The furthest reach point was recorded in centimeters while the participants maintained fully extended knees (19).

Pro-Agility Test (5-10-5 Shuttle Run): The testing setup included cones placed 5 yards (4.57 meters) to the right and left of a designated starting line. A gate was installed at the starting line to mark the beginning of the test. Prior to the test, the athlete stood in a ready position at the center. Upon the starting signal, the participant sprinted to touch the cone on the right, then changed direction to touch the cone on the left, and finally crossed the starting line to complete the test (5).

20-Meter Sprint Test: To assess linear sprint speed, the participating volleyball players were asked to run at maximum effort over a 20-meter flat course, with the track boundaries marked by cones. Each athlete performed two trials, and the best time, recorded in seconds, was used for evaluation (28).

Yo-Yo Intermittent Recovery Level 1 Test (Yo-Yo IR1): The Yo-Yo Intermittent Recovery Test Level 1, developed by Bangsbo, was used to assess aerobic and intermittent recovery capacity in a field-based setting. The test consists of repeated 2 × 20-meter shuttle runs at progressively increasing speeds, interspersed with 10-second active recovery periods (walking or light jogging), guided by audio signals. A 5-meter recovery zone was marked behind the start line. The test continued until the athlete failed twice to reach the finish line in time. The total distance covered was used as the performance criterion (4).

Vertical Jump and Anaerobic Power Test: Vertical jump tests are commonly used to assess lower-body explosive strength and anaerobic power (3). In this study, vertical jump performance was measured using the Fit Jump electronic vertical jump device. The device was placed on the floor, and its photoelectric sensor was aligned approximately 30 cm in front of the participant's mid-foot. Participants began the test with feet shoulder-width apart, knees extended, and hands placed on their hips. Upon command, they were instructed to bend their knees and jump as high as possible, landing simultaneously with both feet in the same starting position. Hands were to remain on the hips throughout the test. Each athlete was given two attempts, with a two-minute passive rest interval between trials. Jump height and flight time were recorded via the device monitor, and the best performance was recorded in seconds (47).

Dynamic Balance Test (Y-Balance Test): The Y-Balance Test was applied to assess the overall dynamic balance of the lower and upper extremities. Validity and reliability studies of the test were conducted by Plisky et al. (32) with reported intrarater reliability (ICC = 0.85–0.91) and interrater reliability (ICC = 0.99–1.00). Participants wore sports attire and performed the test barefoot. The dominant foot was placed at the center of the Y-Balance testing device, while the other foot reached in the anterior (0°), posteromedial (45°), and posterolateral (45°) directions, touching the target blocks with the tip of the toe without losing balance. Each direction was tested three times, and the mean of the reach distances was calculated and recorded in centimeters (cm).

Data Collection

Ethical approval for the study was obtained from the Ethics Committee for Social and Human Sciences of Recep Tayyip Erdoğan University (Decision No: 2025/151, dated 09/04/2025). Permission was also granted by the Ministry of National Education (MoNE) under document number 2025/024029 to examine the participants' lower extremity explosive power, linear speed, agility, balance, and flexibility. Coordination was established with the relevant school administrations to conduct the measurements at appropriate times. Informed consent was obtained from both the athletes and their parents through a voluntary participation and informed consent form.

The data collection process was carried out on an indoor volleyball court with a hard surface, coordinated with the participating teams' weekly training schedules. Participants took part in two experimental trials under similar environmental conditions, scheduled before two consecutive training sessions. A 72-hour interval was maintained between trials. In the first trial, tests were conducted without knee pads and arm sleeves; in the second trial, the same test procedures were repeated while using knee pads and arm sleeves. Before each trial, a standardized warm-up protocol was administered, consisting of moderate-intensity jogging (5–10 minutes) followed by static and dynamic stretching exercises (5 minutes).

Data Analysis

Data were analyzed using IBM SPSS Statistics version 29.0. Descriptive statistics were used to summarize the athletes' demographic and baseline characteristics. The normality of data distribution for all dependent variables was assessed using the Kolmogorov-Smirnov test. To determine differences in lower extremity explosive strength, linear speed, agility, endurance, balance, and flexibility, a paired samples t-test was performed.

The magnitude of the differences between the two conditions was assessed using effect size (ES) analyses, categorized as follows: trivial = 0.20; small = 0.20–0.49; moderate = 0.50–0.79; and large ≥ 0.80 (11). The results were reported as mean ± standard deviation (SD), and the level of statistical significance was set at $p < 0.05$.

FINDINGS

Descriptive statistics for the 133 volleyball players who participated in the study are presented in Table 2. The participants' average year of birth was 2012.24 ± 1.80 (approximately 11 years old). The mean height was 153.48 ± 10.66 cm, and the mean body weight was 49.37 ± 13.68 kg. On average, the athletes participated in training 2.71 ± 0.45 days per week and had been playing volleyball for 2.44 ± 1.42 years.

Table 2. Descriptive Statistics of the Participants

Variables	N	Minimum	Maximum	Mean ± SD
Age	133	2015	2008	2012,24±1,80
Height	133	126	175	153,48±10,66
Weight	133	24	96	49,37±13,68
Number of Weekly Training Sessions	133	2	3	2,71±0,45
Years Playing Volleyball	133	1	7	2,44±1,42

Min = Minimum, Max = Maximum, SD= Standard Deviation

The findings related to the motor performance test results of the participants based on their use of knee pads and arm sleeves are presented in Table 3. Statistically significant differences were found across all variables between the athletes who wore knee pads and arm sleeves and those who did not ($p < .05$).

Table 3. Pre-test and Post-test Results of Participants Under Different Conditions

Variables	Conditions		*p*	*ES (Cohen's d)*	*95% CI (Lower–Upper)*
	Pre-test (No Knee Pads and Elbow Pads)	Post-test (Knee Pads and Elbow Pads)			
Flexibility (cm)	31,30 ± 7,58	29,41 ± 7,46	0,001	0.359	0.183–0.534
Posteromedial (cm)	69,68 ± 14,88	63,43 ± 13,54	0,001	0.475	0.295–0.654
Anterior (cm)	56,37 ± 8,40	53,79 ± 8,13	0,001	0.379	0.203–0.555
Posterolateral (cm)	71,53 ± 13,44	64,70 ± 12,20	0,001	0.675	0.485–0.862
Vertical Jump (cm)	34,14 ± 6,63	33,13 ± 6,95	0,005	0.250	0.077–0.422
20 Meters (sec)	3,94 ± 0,38	4,00 ± 0,37	0,012	-0.221	-0.393–-0.049
Pro-Agility Test (sec)	6,59 ± 0,58	6,71 ± 0,60	0,003	-0.264	-0.437–-0.091
Yo-Yo Intermittent Recovery Level 1 Test (m)	282,86 ± 162,72	261,20 ± 134,96	0,040	0.179	0.008–0.350

ES= Effect Size, *p < .05

In the flexibility test, the mean score of athletes who did not use knee pads and arm sleeves (31.30 ± 7.58 cm) was significantly higher than that of those who did use them (29.41 ± 7.46 cm), and this difference was statistically significant ($p = .001$). Similarly, in the Y-Balance Test, significant differences favoring the non-user group were observed in the posteromedial, anterior, and posterolateral directions ($p = .001$ for all comparisons).

A similar trend was noted in the vertical jump test, where non-users (34.14 ± 6.63 cm) demonstrated higher performance compared to users (33.13 ± 6.95 cm) ($p = .005$).

In the 20-meter sprint and Pro-Agility Test, which assess speed and agility, the group not wearing knee pads and arm sleeves also outperformed the user group ($p = .012$ and $p = .003$, respectively).

Furthermore, results from the Yo-Yo Intermittent Recovery Test Level 1, which evaluates aerobic endurance, showed that the non-user group achieved a significantly greater average distance (282.86 ± 162.72 m) compared to the user group (261.20 ± 134.96 m) ($p = .040$).

The calculated effect size (ES) values were notably high in some tests (e.g., posteromedial and posterolateral directions), suggesting that the use of knee pads and arm sleeves may have adverse effects on certain aspects of motor performance.

DISCUSSION AND CONCLUSION

This study investigated the effects of knee pad and arm sleeve usage on motor performance in female athletes actively participating in inter-school competitions. The findings revealed that these protective equipment items might have adverse effects on certain motor performance parameters.

Regarding flexibility performance, athletes who did not use knee pads and arm sleeves achieved significantly higher scores compared to those who did. This suggests that such protective gear may restrict joint range of motion and thereby hinder the full execution of flexibility-based movements. This outcome aligns with the findings of Hume and Gerrard (21), who reported that while knee pads enhance joint stability, they may also impose movement restrictions. Although existing literature on the direct effects of knee pads and arm sleeves on flexibility is limited, further research in this field may lead to more informed decisions regarding the design, materials, and usage of protective equipment. Since flexibility is crucial for athletic performance and injury prevention, developing equipment that offers protection without compromising range of motion is essential for athlete health and performance.

In dynamic balance assessments—specifically the posteromedial, anterior, and posterolateral reach directions—non-users of protective equipment outperformed users, reaching significantly greater distances. This suggests that knee pads and arm sleeves might hinder lower extremity stability and freedom of movement, thus negatively affecting dynamic balance. Although designed to prevent injuries, such equipment might limit proprioceptive feedback, reducing performance in balance-related movements. These findings are supported by previous studies. For instance, Paterno et al. (30) found that athletes wearing knee braces scored lower in balance tests, possibly due to mechanical restrictions around the knee. Similarly, Bennell and Hinman (6) reported that knee brace usage significantly decreased both static and dynamic balance performance in individuals with knee osteoarthritis. These results imply that the impact of protective gear may vary depending on the athlete's health status, type of equipment, and intended use. Therefore, knee pads and arm sleeves should be used cautiously and tailored to individual needs, particularly in activities requiring precise motor control.

In the vertical jump test, which assesses lower extremity explosive strength, athletes without protective gear demonstrated significantly higher jump heights than their counterparts. This supports the notion that such equipment may limit joint mobility—especially around the knees and elbows—thereby reducing the muscle's capacity to generate maximum power (29). However, the literature presents mixed findings. Lazić et al. (26) reported that knee pad usage had no statistically significant effect on vertical jump performance in female athletes. This suggests that the performance impact of protective gear may vary according to individual differences, type of equipment, level of habituation, and test characteristics. Hence, athletes should select protective gear based on their specific performance needs, recognizing that such equipment may affect various performance parameters differently.

This study is significant for comprehending the effects of knee pads and arm sleeves on volleyball performance and for providing a comprehensive strategy to athlete development. This suggests that protective equipment may reduce movement efficiency in both upper and lower extremities, negatively affecting high-speed activities such as sprinting. The feeling of tightness and material resistance created by such gear may inhibit the athlete's ability to move freely and naturally. Similar findings in the literature indicate that protective equipment may limit running speed, particularly in short-distance sprints (23, 36, 46). Therefore, when designing training programs and competition conditions aimed at enhancing sprint performance, it is crucial to consider the potentially restrictive effects of protective equipment.

According to the Pro-Agility test results assessing agility, athletes who did not use knee pads or sleeves completed the test in a shorter time, indicating superior performance. This finding suggests that protective equipment may impair performance in movements involving rapid directional changes, acceleration, and deceleration. Knee pads and sleeves may mechanically restrict natural movement patterns, particularly hindering the rapid repositioning of the lower extremities. This observation is supported by prior studies indicating that athletes using knee pads may experience limited control and movement speed during agility tasks involving sudden directional shifts (9, 18). Thus, in performance areas requiring high levels of motor coordination and rapid reactions, the potential limiting effects of protective equipment should be considered.

In the Yo-Yo Intermittent Recovery Level 1 test used to evaluate endurance and intermittent recovery capacity, athletes not using knee pads and sleeves covered significantly more distance than users. This suggests that protective equipment may restrict movement freedom during prolonged and high-intensity exercise, adversely affecting energy efficiency and performance. The support and protection provided by such equipment may hinder natural movement mechanics and impose additional strain during recovery processes. Similar findings have been reported in the literature. Bizzini et al. (8) emphasized that supportive gear might negatively impact movement quality during endurance tests, while Adams (1) noted that such equipment may affect not only mechanical movement limitations but also thermoregulation during intermittent performance tests. These insights underscore the need to consider both mechanical and physiological impacts of protective gear.

From a neuromechanical perspective, the decreased performance observed in this study could be attributed to alterations in proprioceptive feedback and joint kinematics caused by the use of protective equipment. Knee pads and arm sleeves may dampen sensory input from mechanoreceptors around the joints, leading to delayed neuromuscular responses and reduced movement precision. Additionally, the external compression and material stiffness of such equipment might restrict the natural stretch–shortening cycle of muscles, impairing coordination and force generation during dynamic movements.

Practical implications for coaches and athletes highlight that protective gear should not be regarded as universally beneficial or detrimental. Instead, its use should be context-specific. For example, protective equipment may be recommended during high-risk drills or recovery sessions but should be minimized during skill acquisition and speed-oriented training, where unrestricted movement and sensory feedback are critical. Coaches are encouraged to monitor athletes' responses to equipment use and adjust training intensity or duration accordingly. Moreover, manufacturers should continue to develop ergonomic, lightweight, and breathable designs that ensure both protection and performance.

In conclusion, this study provided a framework for evaluating the contributions and potential limitations of protective equipment within the context of motor performance. The findings indicated that knee pads and arm sleeves—although primarily used for injury prevention—may negatively affect fundamental performance areas such as flexibility, balance, vertical jumping, speed, agility, and intermittent recovery. Notably, non-users outperformed users across all tests. This may be attributed to the movement restrictions imposed by protective gear, limiting joint and muscle function and preventing athletes from utilizing their motor skills to full capacity. As supported by previous research (31, 35, 38), knee pads and arm sleeves are critical for injury prevention. However, their potential to limit performance should not be overlooked. Therefore, athletes should be educated about the use of such equipment prior to training and competition, and equipment should be selected based on the demands of the sport and the individual needs of the athlete. Manufacturers are also encouraged to design ergonomic, lightweight gear that minimizes restriction of movement.

This study has certain limitations that should be taken into account when interpreting the results. The sample consisted solely of female athletes aged 10–17 years from a single region, which may limit the generalizability of the findings. Furthermore, the lack of a control group and the short-term nature of the assessment constrain the ability to determine long-term adaptation or causality. Future research should therefore employ longitudinal and comparative designs that include both sexes, a wider range of age groups, and athletes from different sports disciplines to obtain a more comprehensive understanding of the effects of protective equipment on performance.

Beyond physical performance outcomes, future studies should also investigate the psychological and neuromechanical dimensions of protective equipment use. Examining factors such as self-confidence, motivation, proprioceptive sensitivity, and motor control could provide deeper insight into how knee pads and arm sleeves influence both perception and movement efficiency. Integrating these perspectives will allow researchers and practitioners to make evidence-based recommendations regarding when and how protective gear should be utilized in training and competition. Ultimately, a holistic understanding of both the mechanical and psychological implications of protective equipment will contribute to optimizing athlete safety, comfort, and performance effectiveness.

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