Central European Journal of Sport Sciences and Medicine | Vol. 45, No. 1/2024: 65–74
ISSN (print): 2300-9705 | ISSN (online): 2353-2807 | DOI: 10.18276/cej.2024.1-05

CLINICAL IMPLICATIONS OF SQUAT JUMP AND COUNTERMOVEMENT JUMP AMONG YOUNG FEMALES OF UNITED ARAB EMIRATES: COMPARATIVE BIOMECHANICAL ANALYSIS

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[A] Study Design; [B] Data Collection; [C] Statistical Analysis; [D] Manuscript Preparation;

Abstract

Background: The countermovement jump (CMJ) and the squat jump (SJ) are two vertical jump (VJ) tests widely used to evaluate lower limb muscle strength and power, respectively. Biomechanical analysis of SJ and CMJ could help to predict the strength associated musculoskeletal clinical disorder which is most commonly seen among females such as patellofemoral pain syndrome, osteoarthritis etc. Therefore, the purpose of the study was to conduct and compare the biomechanical analysis of squat and countermovement jump using advanced motion analysis system and compare the changes among sedentary and active young females of the United Arab Emirates.

Methodology: The experimental study was conducted at the Thumbay Physical Therapy and Rehabilitation Hospital, Gulf Medical University, Ajman, UAE. A total of 60 sedentary females, and 60 active females within age group 18–30 years were recruited under the convenience sampling method. The participants were randomly divided into two subgroups of 30 each for SJ and CMJ jump analysis respectively for sedentary and active group.

Results: There was a statistically significant difference between the CMJ and SJ among the young females in UAE population ($p < 0.05$). The outcome variables such as jump height, and lower limb joint force were significantly reduced for SJ and CMJ in the sedentary group compared to active group. Majority of the variables showed moderate to severe effect size.

Conclusion: Based on the study findings, it could be suggested that the "Sedentary Group" in the present study had poor muscle strength and ability to sustain the stress on the lower limb joints as also shown with lower mean total work. Since we have conducted the study on healthy non-athletes' young females, the data could be used for further clinical correlation and comparison for lower limb muscle strength and power.

Key words: squat jump, countermovement jump, young females, biomechanical analysis, United Arab Emirates

Introduction

Exercise and general physical activity play a significant role in our life. The World Health Organization (WHO) emphasizes the need and encourages younger adults to engage in any form of exercise to prevent related future complications. Under-exercising is practiced by about 31% of the world's population under the age of 15, which is believed to cause 3.2 million fatalities annually (WHO). In the United Arab Emirates, there is a general lack for understanding the importance of physical activity (PA) among females of all age group. A study published in 2016 reported poor exercise involvement among young residents of UAE suggesting plans to improve physical activity among college and university students to reduce future levels of chronic diseases (Yammine, 2017). Studies have also suggested that the children and youth in UAE aren't achieving minimum requirements for daily physical activity (Paulo et al., 2023). A recently published study in UAE reported physical inactivity in over 58% in the young population comprising university students (Dalibalta et al., 2021). The study concluded both young females and males spend more than 12 hours each day inactive, accounting for more than 80% of their waking hours (Dalibalta et al., 2021). A local survey in the UAE reported that 41% of the young population does not get enough weekly exercise to live a healthy lifestyle, increasing the risk of health difficulties later in life. Poor physical activity has a positive correlation with musculoskeletal strength and conditioning (Nabeel et al., 2007). Lack of exercise and physical activity could produce similar ill effects of immobilization on the musculoskeletal system such as lower limb strength and power which is most significantly affected (Ilkka Vuori, 1995). It is well known that poor lower limb muscle strength could be associated with multiple musculoskeletal disorder and affect the overall quality of life. Females could be at higher risk for developing future atraumatic as well as traumatic musculoskeletal disorders due to poor conditioning in their initial stages of life. The lower limb and the trunk related musculoskeletal disorder has been found to be higher and thus requires adequate strength and power to counter the effects of gravitational kinetics (Antle et al., 2013).

Studies report that countermovement jump (CMJ) and the squat jump (SJ) are two vertical jump (VJ) tests widely used to evaluate lower limb muscle strength and power, respectively (Van Hooren et al., 2017). These tests are more functional compared to isokinetic testing and thus could be used more effectively in clinical set up. Both the tests target the lower body predominately along with the use of muscles above the waist making it a comprehensive testing and training method. There is a characteristics biomechanical difference between the SJ and CMJ. The SJ is a type of jump that is executed while squatting. When performing a countermovement jump (CMJ), one begins from a standing position, flexes their knees and hips to make a downward motion, and then immediately extends their knees and hips to jump vertically off the ground making efficient use of short- stretching cycle phenomenon (Van Hooren et al., 2017). The SJ target lower limb muscles such as Gluteus Maximus, Gluteus Minimus, Gluteus Medius, Quadriceps, Hamstrings, hip adductors, hip flexors, and Gastrosoleus unit. In addition, it also stimulates the core muscles which allows better balance of the body (Van Hooren et al., 2017). A CMJ equally targets the lower limb strength and power with a focus on muscles such as Adductor Longus, Semitendinosus, and Biceps femoris (Van Hooren et al., 2017). A study published in the literature found that the CMJ produces a higher jump height than the squat jump (SJ). A 20-30% rise over the SJ height is typical (Nygaard Falch et al., 2020). Furthermore, the Squat Jump test can be used to assess concentric-only force application. It is helpful to understand the difference between the two jumps in context to public health among adolescence. The jumps are biomechanically comparative (kinetics and kinematics) (Mackala et al., 2013) and thus could be effectively used to determine the lower limb structure and function (bone and muscular strength and muscle power generation). Although multiple studies have been done to assess the biomechanical changes in SJ and CMJ for athletic performance, we believe that data for clinical use is scarce and must be explored for clinical significance. It is well known and reported that females are at higher risk for developing musculoskeletal disorders in later stages of their life due to lack of physical activity leading poor muscle strength and reduction in bone density. Since the ability to perform a good squat and countermovement jump reflects the integrity of the neuro-muscular system, it would be useful to perform a biomechanical analysis among young female adults. Therefore, the purpose of the study is to conduct the biomechanical analysis of squat and countermovement jump using advanced motion analysis system, suggest their clinical implications while compare the changes among young females of the United Arab Emirates. The objectives of the study were as follows:

- To determine the biomechanical for SJ and CMJ among young sedentary and active females of UAE population.
- To compare changes the jump height, maximum force, absolute & relative power, flight time, maximum speed and acceleration for SJ and CMJ among young sedentary and active females of UAE population

Methods

An experimental study was conducted at the Thumbay Physical Therapy and Rehabilitation Hospital, Gulf Medical University, Ajman, UAE. The study protocol was approved by the Institutional Review Board (IRB/ COHS/ STD/36/Feb-2022) following which participants were recruited after obtaining the informed consent form under the following inclusion and exclusion criteria.

Inclusion criteria: Young females (Gulf Medical University students from all programs), within an age group 18-25 years, sedentary lifestyle as per WHO recommendation (characterized by expenditure of 1.5 METs or less energy while in sitting, lying, or recycling posture) (Park et al., 2020; Tremblay et al., 2017). Age matched active young females (at least 150–300 minutes of moderate-intensity; or at least 75–150 minutes of vigorous-intensity physical activity, or an equivalent combination of moderate- and vigorous-intensity physical activity achieving at least 600 MET-minutes) in a week.

Exclusion criteria: participants with acute lower limb joint pain, diagnosed with musculoskeletal and metabolic disorders, pregnant, and active menstrual cycle.

Procedure: Recruitment of participants began after obtaining the informed consent from all. A total sample size of 120 participants was statistically obtained divided equally into two groups (n = 60 “Sedentary group”; and n

= 60 “Active group”) with further sub group (n = 30 SJ, and n = 30 CMJ for each defined group). The sample size calculation was done using jump height as primary variable in the formula for comparison of means using G power test. The selection of participants into defined “Sedentary” and “Active” group was done using the convenience sampling method and information based on their prior physical activity level using GPAQ questionnaire. Whereas the selection of participants in the SJ and CMJ were done using a simple randomization technique for each defined group. The outcome variables of interest were max jump height (m), max force (N), max absolute power (W), flight time (s), max speed (m/s), max acceleration (m/s2), max rel. power (W/kg) and total work (J). The description for SJ and CMJ tests varies in the literature and standardized test protocol has been suggested (Petrigna et al., 2019). In the present study, we followed the procedure manual as reported in the outcome measure (D-WALL Elite, Technobody, Software V 3.2.5.0). It consisted of the force platform, the 3D camera, video wall, touch screen monitors 16”, TecnoBody key and polar software package (Figure 1). Participants were placed on the force platform to perform the respective jump and kinetic and kinematic data was generated by the system (Figure 2).

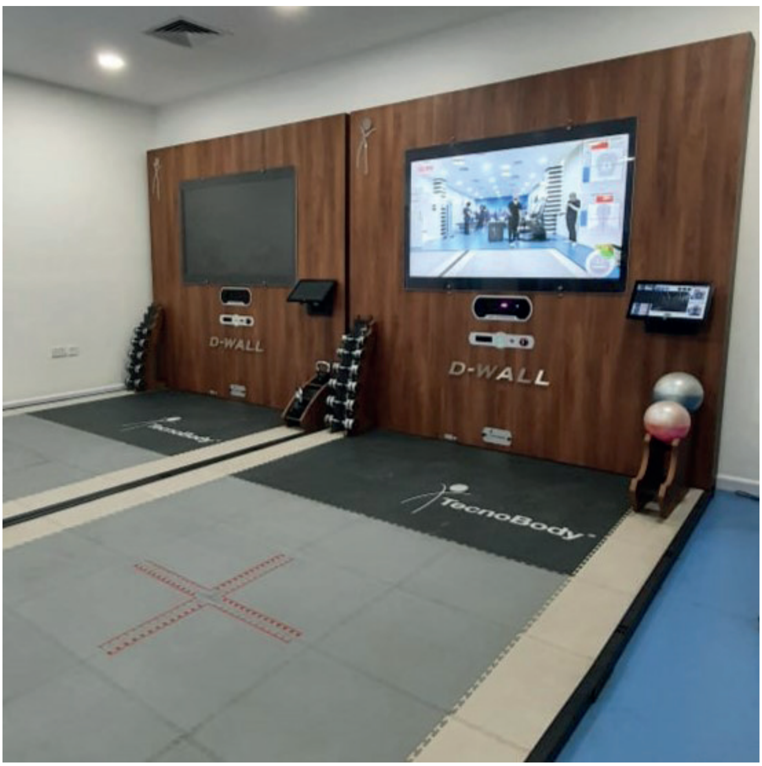

Figure 1. D-WALL Elite system used for SJ and CMJ analysis

Figure 2. Participant onto the force platform for performing the jump

Test Protocol for SJ test step wise:

1. Participant stepped onto the force platform
2. Participant got into a squatting position and held steady.
3. On cue, the participant engaged his or her leg muscles and exploded upwards.
4. The participant landed on the force plates and waited until the test was completed

Test Protocol for CMJ test step wise:

1. Participant stepped onto the force platform.
2. The participant remained immobile to provide a quiet phase
3. The participant immediately transitioned from bending forward at the hip and knees and jumping into the air on cue.
4. The participant landed on the force plates and waited until the test was completed

Results

All data collected was statistically analyzed using the Statistical Package for the Social Sciences (SPSS) version 21 (SPSS Inc., Chicago, IL, USA). A descriptive analysis was done to determine the demographics of all participants followed by a test for normality. The Paired t-test was used for within group analysis and Unpaired t-test was used for between group analysis.

Table 1 depicts the demographic characteristics of participants of the study compared at baseline. Tables 2a & 2b present the findings of CMJ and SJ groups on variables considered for this study. Tables 3 and 4 depict the within group and between group analysis respectively.

Table 1. Demographic characteristics of participants in the study

Variables	Countermovement Jump (CMJ) (n = 60)		p value
	Sedentary Group (n = 30)	Active Group (n = 30)	
	Mean (SD)	Mean (SD)	
Height in cm	164.4 (7.9)	163.1 (3.1)	0.74
Weight in kg	65.6 (13.0)	61.0 (6.6)	0.14
Body Mass Index (BMI)	23.85 (3.1)	21.7 (2.0)	0.38
	Squat Jump (SJ) (n = 60)		
Variables	Sedentary Group (n = 30)	Active Group (n = 30)	p value
	Mean (SD)	Mean (SD)	
Height in cm	162.6 (8.2)	161.0 (4.1)	0.54
Weight in kg	63.5(9.4)	60.8 (6.6)	0.07
Body Mass Index (BMI)	22.9 (3.7)	21.05 (2.0)	0.09

Table 2a. Findings for Countermovement Jump (CMJ) in Sedentary and Active groups

Variables	Sedentary Group (n = 30)	Active Group (n = 30)
	Mean (SD)	Mean (SD)
Max. jump height in meters (m)	0.3 (0.1)	0.4 (0.2)
Max. force in newtons (N)	1263 (344.2)	1352 (350)
Max. absolute power in watts (W)	2211.5 (701.7)	2783 (776.2)
Flight time in seconds (s)	0.35 (0.1)	0.49 (0.03)
Max speed in meter per second (m/s)	2.0 (0.3)	2.9 (0.2)
Max acceleration in meter per second square (m/s^2)	11 (2.8)	14 (3.1)
Max relative power in watt per kilogram (W/kg)	38.1 (14.6)	44.3 (11.2)
Total work in Joules (J)	177.5 (57.4)	201.4 (60.8)

Table 2b. Findings for Squat Jump (SJ) in Sedentary and Active groups

Variables	Sedentary Group (n = 30)	Active Group (n = 30)
	Mean (SD)	Mean (SD)
Max. jump height in meters (m)	0.3 (0.1)	0.4 (0.02)
Max. force in newtons (N)	1220.8 (204.6)	1311.3 (298.2)
Max. absolute power in watts (W)	2215 (511.2)	2984 (651.0)
Flight time in seconds (s)	0.3 (0.04)	0.5 (0.06)
Max speed in meter per second (m/s)	1.9 (0.3)	2.8 (0.3)
Max acceleration in meter per second square (m/s^2)	13.63 (2.3)	14.1 (2.9)
Max relative power in watt per kilogram (W/kg)	37.7 (5.4)	43.1 (13.0)

Total work in Joules (J)	163.8 (42.7)	198.6 (55.2)

Table 3. Comparison of SJ and CMJ within group analysis (Paired t-test)

Variables	Sedentary Group (n = 60)		Active Group (n = 60)	
	P value Sig. ≤0.05)	Effect Size (Cohen's d)	P value Sig. ≤0.05)	Effect Size (Cohen's d)
Max. jump height in meters (m)	**0.051**	0.57	0.080	0.26
Max. force in newtons (N)	**0.003**	0.41	**0.038**	0.78
Max. absolute power in watts (W)	0.190	0.02	0.640	0.41
Flight time in seconds (s)	0.081	0.50	0.610	0.35
Max speed in meter per second (m/s)	0.125	0.43	0.330	0.12
Max acceleration in meter per second square (m/s^2)	**≤ 0.001**	0.91	**0.010**	0.85
Max relative power in watt per kilogram (W/kg)	**0.031**	0.72	0.091	0.39
Total work in Joules (J)	0.298	0.24	0.612	0.26

Table 4. Comparison of SJ and CMJ between group analysis (Unpaired t-test)

Variables	Sedentary Group Vs Active Group for SJ (N=60)		Sedentary Group Vs Active Group for CMJ (N=60)	
	P value Sig. ≤0.05)	Effect Size (Cohen's d)	P value Sig. ≤0.05)	Effect Size (Cohen's d)
Max. jump height in meters (m)	**≤ 0.001**	0.75	**0.005**	0.63
Max. force in newtons (N)	**0.002**	0.81	**0.021**	0.89
Max. absolute power in watts (W)	**≤0.001**	0.68	**≤0.001**	0.72
Flight time in seconds (s)	**≤0.001**	0.59	**0.038**	0.56
Max speed in meter per second (m/s)	**≤0.001**	0.88	**0.004**	0.88
Max acceleration in meter per second square (m/s^2)	**≤0.001**	0.89	**0.033**	0.53
Max relative power in watt per kilogram (W/kg)	**0.004**	0.77	**0.001**	0.92
Total work in Joules (J)	**0.051**	0.84	**≤0.001**	0.95

Discussion

The focus of the study was to use the SJ and CMJ for clinical implications in physical therapy while understanding the biomechanical difference between SJ and CMJ for sedentary and active young females in the United Arab Emirates. The finding from the study as represented in Table 1 suggested that there was no statistical difference in the demographic characteristics of participants in SJ and CMJ for both sedentary and active groups respectively ($p > 0.05$), thus making the groups comparable. However, the biomechanical analysis for the SJ and CMJ showed statistical as well as clinical significance for both within and between group analysis.

Our study found that the mean values for biomechanical kinematic variables like maximum jump height, flight time, maximum speed, and maximum acceleration were higher in the "Active Group" compared to the "Sedentary Group" for both SJ and CMJ. Similar findings were obtained for the kinetic variables such as maximum force, maximum absolute power, maximum relative power and total work suggesting that the “Active Group” had better baseline strength and power in the lower limbs. These findings were anticipated as having better conditioning among the “Active Group” participants compared to the “Sedentary Group” who spent their maximum time in sitting leading to deconditioning effects. Since the vertical jumps like SJ and CMJ have been mostly used among the athletes, the baseline data could not be compared to our study. In addition, the study focused on its clinical implication, and not on performance in sports competition as compared to the previous studies. Moreover, the biomechanical variables selected in the present study are not only controlled by the musculoskeletal system, rather through a coordinated and sequential action of neuro-muscular system suggesting that the “Sedentary Group” could have poor control on the neuromuscular action compared to the “Active Group”. A recently conducted study found a strong, independent positive correlation between sedentary behaviors and cognitive functions representing neuromotor skills (Wanders et al., 2021). In line with the previous studies (Donahue et al., 2021), our study found that kinematics like the mean jump height was greater in the CMJ against the SJ for both “Active Group” and “ Sedentary Group” of participants (mean jump height for CMJ = 0.30 m compared to 0.26m in sedentary group and mean jump height for CMJ = 0.41 m compared to 0.37 m in the active group, Table 2a and 2b). Similar finding were seen for the mean maximum/peak absolute power which was shown to be higher in SJ compared to the CMJ for both “Active Group” and “ Sedentary Group” of participants (mean maximum power for SJ = 2215 W compared to 2211.5 W in the CMJ for the sedentary group, and 2984 W in SJ compared to 2783 W for the active group) as also reported in the previous study (Donahue et al., 2021). Higher power output in the SJ compared to the CMJ could be suggestive of higher requirement for force and velocity generation at the lower limb joint during the SJ. The powerful contraction of the Quadriceps muscles along with more angular velocity through bent knee joints could be responsible for such findings. But when we compared the maximum force for SJ and CMJ we found that the mean values were smaller for SJ in both groups (1220.8 N in SJ compared to 1263 N for sedentary group, and 1311.5 N compared to 1352 N in the CMJ for the active group) which was not in line with the previous finding (Donahue et al., 2021).The reason could be attributed to the difference in the population studied, our study focused on the sedentary and active females compared to the elite athletes in the previous study. In addition, it could be also suggested that participants in our study could not have attained the same biomechanical skills and techniques for vertical jumps as seen among the athletes and thus not representing the jumps as performance which could be contributed by many other factors (neural inputs, number type of muscle fibers activation, environmental factors etc.). In our study, we conducted these jumps to understand the force and power generation as function of the musculoskeletal system solely and use it for clinical implications. Poor force and power generation could be associated with higher chances of various musculoskeletal conditions such as osteoarthritis, sprain, strain, fracture etc. and overall deconditioning. Though we could not find data to compare the normative values for SJ and CMJ among the non-athlete female population within the included age group, it was evident that the “Sedentary Group” participants showed lower mean values for all variables compared to the “Active Group” participants. Thus, sedentary females could be at higher risk for musculoskeletal disorders. While the young age group is most often neglected, multiple musculoskeletal disorders have been reported in young females where back pain and postural changes are most commonly seen (Guan et al., 2023). These musculoskeletal conditions are biomechanically linked in close chain kinematics where the force from the ground is transferred to the lower limb at ankle, knee, hip and vertebral segments. Any changes in the transfer of the force in terms of efficiency and sequential muscle action could lead to repetitive stress on the joints which are the most important etiological factors for musculoskeletal conditions. Findings from our study suggested that there was a significant difference with moderate to high effect size for most of the variables when within and between group analysis was done (Table 3, Table 4). Higher effect size was suggestive of clinical significance between the "Active Group" and " Sedentary Group" in addition to statistical difference (Table 4).

The SJ and CMJ jump not only could reveal the biomechanical characteristics but could also be used to assess the power and joint force clinically since they are more functional (Lees et al., 2004). The SJ and CMJ could closely represent the functional activities in our life and thus should be used for clinical assessment. We suggest that squat jump analysis could be routinely performed and correlated with Repetition Maximum (RM) for better clinical interpretation of muscle strength and power. The lower mean values for SJ analysis are suggestive of poor muscular strength which is directly representative of muscle force and coordination.

Conclusion

Based on the study findings, it could be suggested that the " Sedentary Group" in the present study had poor muscle strength and ability to sustain the stress on the lower limb joints as also shown with lower mean total work. Since we have conducted the study on healthy non-athletes' young females, the data could be used for further clinical correlation and comparison for lower limb muscle strength and power. Appropriate training could be given to improve the SJ and CMJ performance among sedentary young females and hence improve their biomechanical functions, thereby reduce the risk of short term and long-term musculoskeletal problems.

References

Antle, D. M., & Côté, J. N. (2013). Relationships between lower limb and trunk discomfort and vascular, muscular and kinetic outcomes during stationary standing work. *Gait & posture*, *37*(4), 615–619. doi: 10.1016/j.gaitpost.2012.10.004.

Dalibalta, S., Majdalawieh, A., Yousef, S., Gusbi, M., Wilson, J. J., Tully, M. A., & Davison, G. (2021). Objectively quantified physical activity and sedentary behaviour in a young UAE population. *BMJ open sport & exercise medicine*, *7*(1), e000957. https://doi.org/10.1136/bmjsem-2020-000957

Donahue, P. T., Wilson, S. J., Williams, C. C., Hill, C. M., & Garner, J. C. (2021). Comparison of Countermovement and Squat Jumps Performance in Recreationally Trained Males. *International journal of exercise science*, *14*(1), 462–472.

Guan, S. Y., Zheng, J. X., Sam, N. B., Xu, S., Shuai, Z., & Pan, F. (2023). Global burden and risk factors of musculoskeletal disorders among adolescents and young adults in 204 countries and territories, 1990-2019. *Autoimmunity reviews*, *22*(8), 103361. Advance online publication. https://doi.org/10.1016/j.autrev.2023.103361

Ilkka Vuori M. D (1995). Exercise and Physical Health: Musculoskeletal Health and Functional Capabilities, *Research Quarterly for Exercise and Sport*, *66*(4), 276–285, https://doi.org/10.1080/02701367.1995.10607912

Lees, A., Vanrenterghem, J., & De Clercq, D. (2004). The maximal and submaximal vertical jump: implications for strength and conditioning. *Journal of strength and conditioning research*, *18*(4), 787–791. https://doi.org/10.1519/14093.1

Mackala, K., Stodółka, J., Siemienski, A., & Coh, M. (2013). Biomechanical analysis of squat jump and countermovement jump from varying starting positions. *Journal of strength and conditioning research*, *27*(10), 2650–2661. https://doi.org/10.1519/JSC.0b013e31828909ec

Nabeel, I., Baker, B. A., McGrail, M. P., Jr, & Flottemesch, T. J. (2007). Correlation between physical activity, fitness, and musculoskeletal injuries in police officers. *Minnesota medicine*, *90*(9), 40–43.

Nygaard Falch, H., Guldteig Rædergård, H., & Van den Tillaar, R. (2020). Relationship of Performance Measures and Muscle Activity between a 180° Change of Direction Task and Different Countermovement Jumps. *Sports (Basel, Switzerland)*, *8*(4), 47. https://doi.org/10.3390/sports8040047

Park, J. H., Moon, J. H., Kim, H. J., Kong, M. H., & Oh, Y. H. (2020). Sedentary Lifestyle: Overview of Updated Evidence of Potential Health Risks. *Korean journal of family medicine*, *41*(6), 365–373. https://doi.org/10.4082/kjfm.20.0165

Paulo, M. S., Nauman, J., Abdulle, A., Aljunaibi, A., Alzaabi, M., Barakat-Haddad, C., Sheek-Hussein, M., Shah, S. M., Yousufzai, S., & Loney, T. (2018). Results From the United Arab Emirates' 2018 Report Card on Physical Activity for Children and Youth. *Journal of Physical Activity and Health*, 1*5*(s2), S419–S421. Retrieved Jul 11, 2023. https://doi.org/10.1123/jpah.2018-0543

Petrigna, L., Karsten, B., Marcolin, G., Paoli, A., D'Antona, G., Palma, A., & Bianco, A. (2019). A Review of Countermovement and Squat Jump Testing Methods in the Context of Public Health Examination in Adolescence: Reliability and Feasibility of Current Testing Procedures. *Frontiers in physiology*, *10*, 1384. https://doi.org/10.3389/fphys.2019.01384

Tremblay, M. S., Aubert, S., Barnes, J. D., Saunders, T. J., Carson, V., Latimer-Cheung, A. E., Chastin, S. F. M., Altenburg, T. M., Chinapaw, M. J. M., & SBRN Terminology Consensus Project Participants (2017). Sedentary Behavior Research Network (SBRN) - Terminology Consensus Project process and outcome. *The international journal of behavioral nutrition and physical activity*, *14*(1), 75. https://doi.org/10.1186/s12966-017-0525-8

Van Hooren, B., & Zolotarjova, J. (2017). The Difference Between Countermovement and Squat Jump Performances: A Review of Underlying Mechanisms With Practical Applications. *Journal of strength and conditioning research*, *31*(7), 2011–2020. https://doi.org/10.1519/JSC.0000000000001913

Wanders, L., Bakker, E. A., van Hout, H. P. J., Eijsvogels, T. M. H., Hopman, M. T. E., Visser, L. N. C., Wouters, H., & Thijssen, D. H. J. (2021). Association between sedentary time and cognitive function: A focus on different domains of sedentary behavior. *Preventive medicine*, 153, 106731. https://doi.org/10.1016/j.ypmed.2021.106731

Yammine K. (2017). The prevalence of physical activity among the young population of UAE: a meta-analysis. *Perspectives in public health*, *137*(5), 275–280. https://doi.org/10.1177/1757913916675388

Cite this article as: Saad Salama, T. Y., Abdelkawi Ali, M. A. H., Kandakurti, P. K., Bose, M., Muthukrishnan, R., & Hazari, A. (2024). Clinical implications of Squat Jump and Countermovement Jump among young females of United Arab Emirates: Comparative Biomechanical Analysis. *Central European Journal of Sport Sciences and Medicine*, *1*(45), 65–74. https://doi.org/10.18276/cej.2024.1-05