Pes Planus Plantaris (Flat Foot) Decreases Postural Stability of Basketball Student-athletes through Ground Reaction Force Vector (vGRF)

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Abstract: **Purpose:** The main objective of this study is to determine the *pes planus plantaris* condition can contribute to the disturbance of postural stability on basketball athlete's in static and dynamics activities.
Methods: This cross-sectional quantitative analytical retrospective study on 47 subjects of basketball student-athletes were identified the foot arch index by footprint extensive area, and AMTI Force flat-form (force plate) were determined their postural stability. Subjects were conducted in three activities (static, dynamic vertical jump, and dynamic loading response) for GRF resultant force vectors towards the vertical plane of body mass (W).
Results: Analytical result obtained 80.9% of subjects had *pes planus plantaris*. It shows no significant differences in *pes planus plantaris* incidence in both sexes subject (p>0.005), however, there are differences in athlete's exercise period aspect. Athlete students who have practiced strictly more than 4 years experienced over 50% for *pes planus plantaris*, furthermore, long period exercise were believed stimulating *pes planus*. The average value of GRF forces vectors of *pes planus plantaris* subjects on three different basketball movements shows a significant correlation to postural stability.
Conclusions: *Pes planus plantaris* affected almost basketball athlete regarding the length and intensity of exercise performed. The condition significantly contribute to postural stability disturbance on a static condition, dynamic vertical jump, and dynamic vertical jump loading response.

1 INTRODUCTION

Pes planus and *pes cavus* are leg disorder or lower extremities abnormalities caused by several factors such as standing in a long period, bone disorders and neurological trauma, non-ergonomic shoes, weakness in *ligamentum plantaris*, and *plantar pedis* disorders related to constituent problems of foot imbalance (Aydog S. T., et al., 2004; Chuckpaiwong, et al., 2008; Handrigan, et al., 2012; Sung, P. S., et al., 2017). *Pes planus plantaris* (flatfoot) condition resulting from the occurrence of depression in *arcus longitudinalis medialis* (medial longitudinal arch) can be risk factors of injury in foot overload locomotors (overuse), and the disruption of tissue trauma in *plantar pedis* from persistent weight-bearing continuously (Boerum V., et al. 2003; Sung, Paul S., 2016). *Pes planus plantaris* is a common occurrence that often occurs in the sports community, and the incidence percentage up to 78%. A person with *pes planus plantaris* increases forces and energy consumption while mobilization and higher *plantar* pressure during activity (McCormack, et al., 2001; Sung, Paul S., 2016). Foot arch as contact structure during body weight-bearing and mobilization can be suppressed while excessive weight-bearing activities which lead to lower extremities injury, metatarsals stress fractures, *cuboid syndrome, iliotibial band syndrome, ligamentum calcaneo-navicularis* tear, as well as *plantar pedis* compiler structure stresses. It also related to pathological condition, i.e, diabetes mellitus that can decrease the quality of tendons regenerations (Aydog, S T., 2005; Borton, et al.,

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1997; Chuckpaiwong, et al., 2008; Colo', G., et al., 2021; Mazerolle and Stephanie M., 2007; Ahriyasna, R., et al., 2021).

Basketball as a weight-bearing sport have high intermittent intensity movement involving jumping and landing continuously, acceleration, deceleration, turning, dribbling, shooting, jump shot, jump fake, pull-ups jumpers, pivoting and some interspersed with low slow movement intensity (Bressel E., et al., 2007; Kong, et al., 2015). Jump shot, pull-up jump and jump fake in basketball are such jumping movement with strong foot pushing vertically in both parallel feet on the side of the body. Vertical jump loading response (slam dunk and set shoot*)* is carried out with running and suddenly jumping (weight-bearing loading response) which provides bigger bodyweight pressure in forefoot and midfoot (Kong, et al., 2015; McKeag and Douglas, 2003; Richie and Douglas H., 2007). The main issue on basketball athlete *plantar pedis* is the presence of malformations and injuries due to overuse (excessive usage) on the important intrinsic factors in the foot, such as bone, muscle, tendon, and ligament (Chuckpaiwong, et al., 2008; Clifford, Amanda Marie, and Heather Holder-Powell, 2010). Plantar foot pressure and muscles loading forces during static, walking, and running performances are influenced by foot arch type, especially to flatfoot condition (Koshino, Y., et al., 2020; Sung, P. S., et al., 2017). Biomechanics processes in basketball athletes activities involve running and jumping with fairly high level, high to low intensity, repeated sudden continuous movement on the foot's muscles and ligaments (Aydog S. T., et al., 2004). Running and jumping during basketball game directly affect the postural stability especially in jumping to landing initiation on body fulcrum. The decline of arch curvature is greater in athletes because of body weight load for 3-6 times, especially in jumping activity (Wikstrom, Erik A., et al., 2008). Control of balance is an essential component of human mobility. In some studies, the structure of the foot arch contributes greatly to postural stability in controlling balance. Melzer et. al concluded that higher ground reaction force (GRF) would decrease postural stability (Aydog S. T., et al., 2004; McCormack, Anne P, et al., 2001). These occur because the energy transfer from heel to toe is not through the medial bearing on the forefoot, which relates to rapid high pressure on *hallux,* and the 2nd and 3rd metatarsal (Han, et al., 2011). To analyzing the instability while jumping, the GRF vector is a perfect predictor (Mazerolle, Stephanie M., 2007). The results of this study aim to reduce the resultant amount of GRF to obtain a stable, stronger, and smoother movement. GRF vector analysis was conducted if sexes and longer exercise periods affected the incidence of p*es planus*. These vectors will also predict the athlete's postural stability with varied arch index.

2 METHODS

This study was a cross-sectional quantitative analytical at the Department of Anatomy, Faculty of Medicine, Universitas Indonesia. *The force plate* was explored as stability analysis in Somatokinetic Laboratory in Sports Science Faculty, Universitas Negeri Jakarta (UNJ). We conducted this research from November 2016 to April 2017. Samples are subjects whom basketball student-athletes in the Faculty of Sport Sciences UNJ for 47 consisting of 29 females in the female's basketball club and 18 males in the male's basketball club. They had been acceded written informed consent and approved from the health research ethical committee of Medical Faculty of Universitas Indonesia. Foremost, subjects were screened based on the physical examination criteria, i.e.; training period at least 6 months with exercise frequencies 2 times/week minimally, normal BMI, no abnormalities in the musculoskeletal system of a lower limb, no pain or disorder experienced in the trunk and extremities, no diagnosed neurological disorders, and without under medical treatment.

- Examination of *pes planus'* Footprint

Angle ruler (θ goniometer), stamp ink, and *footprint* diagram paper were served tools to measure athletes' arch index on subjects' *plantar pedis* (fore-foot, mid-foot, hind-foot) related to arch index formulation by Canavagn and McCrory (1997).

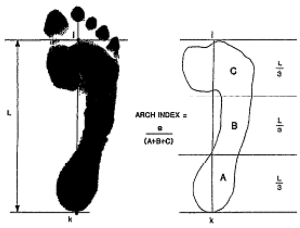

Figure 1: Overview of footprint distribution to calculate subjects arch index (AI) (McCrory, et al., 1997).

We created our footprint stamp pad to maintain the clearance and cleanliness of footprint images generated. Student-athletes would be stepped on those footprint pads to get colored plantar pedis. Further, footprint images were created on footprint diagram paper which we could calculated spacious printed area to be separated subjects arch index then.

- *AMTI (Advanced Mechanical Technology Inc.) Accupower Force Flatform Posturography (Force Plate)*

This computerized based tool generates the body's forces direction vector to determine the amount of GRF vector angle θ against the vertical plane of W with a goniometer device. The examination was executed on basketball student-athletes postures without interrupting their regular exercise schedule and match preparation to avoid injury and fatigue. Examination of static (single-leg standing on dominant leg with contralateral leg flexed approximately 90 degrees) and dynamics postural stability (vertical jump and vertical Jump loading response) was performed for 2 minutes each task (Borton, David C., et al., 1997). The subjects were instructed to generate three activities on task performance with their eyes open. We calculated student-athletes GRF vectors while they were foothold on AMTI force plate devices by single-leg standing (on dominant feet), vertical jump, and vertical jump loading response conditions. We analyzed forces resultants using a standardized formula from angles created between vectors streak and W direction (Figure 3).

- Forces Analysis in Securing Postural Stability Status

Analysis of subject's distribution with *pes planus* and normal arch measured by univariate *chi-square* statistic. The incidence of foot curvature in both sexes and exercise length period had been calculated during a similar analysis. We analyzed the effect of *pes planus* and normal arch in different gender and duration of exercise towards postural stability examined using independent t-test. Statistic analysis directly carried on the effect of each activity of static, dynamic vertical jump, and dynamic vertical jump loading responses. The GRF vector according to body weight (W) formulated in (Headon, Robert, and Rupert Curwen, 2001; Hong, et al., 2016):

$$\boldsymbol{GRFv} = \frac{\boldsymbol{m}\,.\,\boldsymbol{g}}{\boldsymbol{\cos\theta}}$$

The result of forces resultant for GRF vector accumulated in: $\vec{\boldsymbol{F}} = (-\boldsymbol{W}) + \boldsymbol{GRF}$

Higher force resultant formed on GRF compared to the bodyweight force, postural stability will decrease (Headon, Robert, and Rupert Curwen, 2001; Hong, et al., 2016). To sum up, we applied the resultant forces of GRF generated to specify our subject's postural stability.

3 RESULTS

3.1 Characteristics of Research Subjects

Basketball student-athletes (n=47) were active student-athletes in the age of 19.38±1.51 deviation standard. Initial anamnesis involved 18 male students for 19.17±1.38 and 29 female students for 19.48±1.6. Participating subjects have a normal BMI for 21.32±1.4. Student's exercise program runs for 6 days/week, for 120-180 minutes with a 15-30 minute break period. It performed during 18-22 weeks (±5 months) in each semester. We performed the incidence of different foot arch related to genders. It shows a higher percentage of *pes planus* incidence 4 times than normal arch students. However, it revealed no significant differentiation in *pes planus* distribution on both sexes of the subject with *p-value*=0.449 (table 1).

3.2 *Footprint* Results

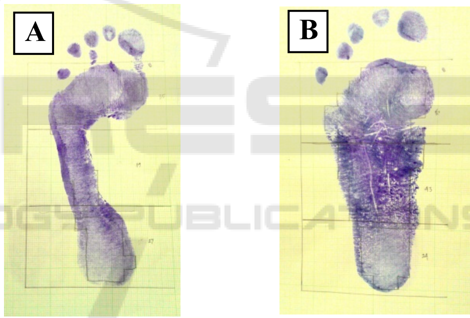

Figure 2: *Pes planus* (A) and normal arch (B) of basketball student-athletes in UNJ.

Table 1: Foot arch distribution of basketball student-athletes for both sexes.

Variables	Foot arch		*P-value*
	Pes planus	Normal	
Men	16 (88.9%)	2 (11.1%)	0.449
Women	22 (75.9%)	7 (24.1%)	
Frequencies	38 (80.9%)	9 (19.1%)	

When we have seen the proportion of *pes planus* subjects, it was found that longer practice performed will lead to an increased incidence of *pes planus*. It was then proven by statistical correlation analysis with a significant value of 0.008 (table 2).

Table 2: Basketball student-athletes foot arch index related to exercise length period.

Variables			Index of the foot arch		Total
			Pes planus	Normal arch	
Duration of exercise (years)	0-4	amount	2	3	5
		% Exercise length	40.0%	60.0%	100.0%
	5-8	amount	30	3	33
		% Exercise length	90.9%	9.1%	100.0%
	9-12	amount	3	3	6
		% Exercise length	50.0%	50.0%	100.0%
	13-16	amount	3	0	3
		% Exercise length	100.0%	.0%	100.0%

	Value	*Df*	*Asymp.Sig. (2-sided)*
Pearson Chi-Square	11,945 [a]	3	.008
Likelihood Ratio	10.753	3	.013

3.3 Postural Stability on *Pes Planus Plantaris* and Normal Arch

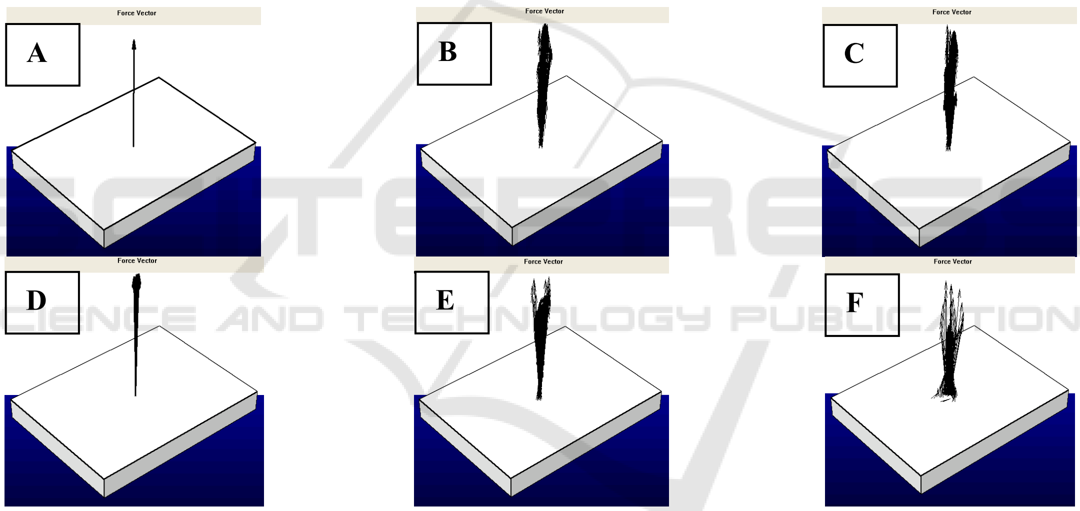

Figure 3: GRF force vector illustration in subjects with normal foot arch (A, B, C) and on *pes planus plantaris* (D, E, F).

3.4 Correlations of *Pes Planus* and Normal Arch to Static Postural Stability

Table 3: Distribution of static postural stability on pes planus and normal arch basketball student-athletes.

	AI	N	*Mean*	*Std. Deviation*	*P-value*
GRF on static	*Pes planus*	38	1.6 632	1.8 4397	.043
	Normal	9	0.3667	0 .32016	

It results in a correlation between the resultant force on GRF magnitude towards subjects postural stability in both two types of foot arch with a significant value of 0.043 (table 3).

3.5 Correlations of *Pes Planus* and Normal Arch for the Vertical Motion *(Vertical Jump & Vertical Jump Loading Response/ Shooting Position)* to Dynamic Postural Stability

Based on the table 4, statistical results with p>0.05 of GRF resultant force magnitude correlated to the foot arch type. It indicates that there is a correlation between the subject postural stability with *pes*

Table 4: Distribution of dynamic postural stability with vertical jump and vertical jump loading response on *pes planus* and normal arch basketball student-athletes.

	AI	N	*Mean*	*Std. Deviation*	*P-value*
GRF on dynamic vertical jump	*Pes planus*	38	15. 2632	8. 82773	.017
	Normal	9	7. 8778	2. 23874	
GRF vector dynamic loading vertical jump response	*Pes planus*	38	30. 9605	15. 21940	.017
	Normal	9	17. 9889	6. 50009	

planus conditions while performing dynamic *vertical jump* activity. A GRF resultant force vector in vertical jump loading response activity shows the greater average value on the subject with *pes planus* than normal arch subjects. Statistical analysis on both *pes planus* and normal foot arch showed significant association to subject postural stability with 0.017.

4 DISCUSSION

4.1 Subject' Characteristics

The subjects had experienced varied pain in the *plantar pedis* such as pain in the ankle, heel, knee, or spine years ago. We believed those findings are consistent with McKeag's (2003) study which states that the highest incidence of lower extremity injuries in basketball athletes, onwards followed by *vertebrae, costae,* and upper extremity injuries. The higher injuries incidence was recorded as *strains, sprains,* and lacerations in foot tissues. Our data disclosed college-level athletes have a higher level of injury in lower extremities rather than high school athletes, or basketball athletes as recreational purposes (McKeag, Douglas, 2003). Distribution of subjects with normal body mass index (BMI) aims to avoid any disturbance of stability due to obesity. As McGraw et al. (2000) study revealed that postural instability in subjects with obesity indicated by the displacement vector of energy consumption compared to subjects without obesity, we keep off concluding abnormal BMI in our research samples to reach significant findings.

Commonly known, postural stability is also affected by the coordination of the brain in the somatosensory system (visual, vestibular, proprioceptive) and motoric (musculoskeletal, joint, soft tissue). In our study, we obtained physical examination to avoid the influence of both system works towards postural stability. Physical examination included personal identity, body weight, height, health problems diagnosis history in lower extremities, and training period. Musculoskeletal system and sensory-motor inspection cover abnormalities are being felt, symmetrical differentiation on both extremities, swelling, pain, gait pattern, muscle tone and strength, motion agility, and lower extremities reflexes. Those examinations revealed our involved research subjects.

4.2 Basketball Student-athletes *Footprint*

In our investigation, we examined the basketball student-athletes arch index by calculating their spacious footprint area on footprint paper (millimeter block). These measurements correspond to the arch index threshold from Cavanagh et al (1997), which is a more accurate predictor of indices types of the foot arch, and it has significant rates closer to the digital scanner footprint (Razeghi, Mohsen, and Mark Edward Batt, 2002). Arch index results obtained footprint of 80.9% subject had *pes planus,* while the rest of it has a normal arch, meanwhile, athletes with high foot arches *(pes cavus)* are naught. A quote from Borton (1997) and Anzai et al. (2014) findings, the incidence of *pes planus* in athletes has been widely reported and causing multifactorial problems (bone disorders, musculoskeletal, and constituent structures disorders, heavy physical activity, obesity, developmental settled *pes planus).*

Pes planus (fallen arch), or also called flatfoot, *planovalgus,* or *calcaneo-valgus,* is a human underlying of decreasing in the medial longitudinal arch of the foot and arch deformity due to changes in the forefoot, mid-foot, and hind-foot area, both starting with symptoms or asymptomatic (Boerum V., et al., 2003; McCormack, Anne P., et al., 2001; Sung, Paul S., 2016). The common *pes planus* incident factor on sportsmen generally starts from decrease or loss of function in *musculus tibialis posterior* as well as injury (tear) in its tendon, frequently on arch support tissues, both on the plantar fascia and ligament composer (Borton, et al. 1997; Yuji Ohta and Emi Anzai, 2014). With the highest *pes planus* incident in UNJ basketball student-athletes, we believe that professional basketball student-athletes do not realize that they have an abnormal arch height throughout their exercise period. *Pes planus* is still regarded as a form of change in basketball athletes which no students effort and intervention in maintaining or rehabilitating their normal arch. Based on our investigations on pes planus incidence, we discovered student-athletes were been wearing flat soles shoes during exercise and do not even care and realize serious problems (generally pain sensation) on their *plantar pedis.* They assumed that can be tolerated and will recover soon because it still within the tolerance limits that would not interfere along with exercise activities.

4.3 Frequency and Exercise Duration of Basketball on *Pes Planus Plantaris*

In Van Boerum et al (2003) research, foot dysfunction will deliver the decreasing function of legs normal structural support. The imbalance in forces along with activities and movements, heavy intensity and repetitive activities, weight gain, and plantar compiler structure weakness, would potentially decrease the level of foot arch curvature, and eventually be flattering the *arcus longitudinal medialis* (Boerum V., et al., 2003). From a basketball student-athletes long period exercise that we revealed, we discovered an increasing incidence of *pes planus*. Analysis indicates the arch index in four (4) years of practice, *pes planus* incidence will elevate periodically. Increasing incidence of *pes planus* on basketball student-athletes related to the length of steps while they are doing intensive exercise. In contrast to the results of Aydog (2004) findings, it is a negative correlation between the incidence of *pes planus* in adolescent basketball player and non-basketball player on 0.497 and 0.890 significancies (Aydog S. T., 2004). However, what we discover, exercise length period contributed to the incidence of *pes planus*. We believe that *pes planus* high percentage incident officially influenced by the exercise intensity and duration taken, indeed before and during their education in the UNJ basketball club. Aydog research (2004) analyzed basketball players on 1-7 years exercise duration followed by 8 hours/week exercise intensity, whereas in our research, subjects performed 1-16 years exercise with 12-16 hours/week. With longer exercise intensity and intensive frequencies every single week, we believed it would give chances of delivering direct injuries due to the over-use of constituent tissues in the foot arch. What we convinced similar to Volkof and Klingele research in Aydog (2004) which regular intensive exercise and increasing prolonged exercise intensity will result in flatfoot *(pes planus)* incidence over running activities during playing basketball.

Another our finding, student-athletes bodyweight loading during exercise is concentrated in the *plantar pedis* forefoot region. The imposition of body weight (weight-bearing) for a long time is often found in student-athletes while running and making leaps during exercise. We believed high-pressure forces in the forefoot will lead to stronger and continuous stretch in the *plantar fascia* and *posterior tibial tendon.* Over-use pulling and stretching conditions will increase the incidence of tissue injury or rupture in *plantar pedis* arch-supporting tissue. The pain had been experienced by the entire subject (100%) at *plantar fascia,* and some pain in the ankle, heel, and knee. In the end, the injuries cause weakness of the arch structure and finally decrease the plantar arch curvature.

4.4 Postural Stability of Basketball Student-athletes

What we investigated, student-athletes postural stability measured in three common basketball activities; standing on a single leg, vertical jump (jump shot, pull-up jumper or fake jump), and vertical jump loading response (shooting, slam dunk, or set shoot). It showed the incidence of *pes planus* on basketball student-athletes postural stability determined instability values. Postural stability prescribed the extent of instability on student-athletes from various activities. As far as we noticed, postural stability in basketball athletes with *pes planus* never been assessed in certain activities, where some basketball studies specifically analyzed postural stability in static conditions. Talking about ground reaction forces examined, Headon (2001) had examined the pressure on the floor for observing vertical components on GRF used in classifying movement. He provided details for implementing movement initiating systems using vertical components on GRF. Similar to Headon's, we calculated forces quantity on the subject's GRF resultant towards the vertical force component (Headon, Robert, and Rupert Curwen, 2001). The magnitude of each force vector created can not be illustrated by the force plate examination imaging that appeared. The data for stability examination was only a vector force line formed on reaction force by research subjects loading action. GRF vector contained in fx, fy, and fz quadrants and only measured force vector angles magnitude to the vertical plane (fy). So, it can be determined the amount of GRF force in subject's loading activities (Önell, Annica, 2000).

Hong (2016) explained, since force plate is a GRF measurement, some studies have utilized force plate as GRF examinations verification on postural stability. Hong revealed there was a significant association on the standard deviation of vertical vector component (vGRF) to postural stability review during sitting, standing, and position change. One empirically previously mentioned that people with younger age have a greater GRF variability than older ages with a single leg standing examination (Hong, et al., 2016). For example, when body bending movement (shifting pivot center towards their body mass), there will be a decreasing acceleration which leads to reduce GRF. Furthermore, when the body does jump motion (moving CoM away from the fulcrum), it will require additional acceleration and acting force on the fulcrum (Headon, Robert, and Rupert Curwen, 2001). With the occurrence of changes in GRF, it affects the normalization of vertical force which further affects the body's stability. When the force required to normalize the GRF vector is bigger, postural stability will decrease.

With different tracking areas in subjects on both arch indexes, we believe that flatter arch curvature, especially in athletes, will reduce postural stability in every activity conducted, both static and dynamic. Similar in Bressel et al (2007) findings, basketball athletes have static and dynamic stability problems rather than in gymnastics and soccer athletes, however, their stability is still impaired in overall athletes than non-athletes subjects. What we analyzed consistent with Kulthanan's (2004) research, different footprint parameter for national and non-national athletes was different from non-athletes. What we believed, fifth metatarsal and long flat index space in athletes was greater than non-athletes subjects. Correspondingly, Bressel et al (2007) claimed that athletes have no interruption at postural stability compared to non-athletes.

4.5 Relations *Pes Planus Plantaris* on Static Activity in Basketball Student-athletes

From the examination results of two arch types in static postural stability, it revealed association value (*$p<0.05$*). It explains that the *pes planus* subject experienced decreasing postural stability which leads to the unstable conditions of GRF resultant toward the body's vertical plane. Postural stability by calculating GRF forces on static condition have a similar tendency with Onell (2000) research. Onell revealed although the magnitude of vertical force could be compared, the vertical force component simultaneously similar to normal and healthy subjects after stroke (CVA - *cerebral vascular accident)*. In Sung (2017) study, flatfoot group had no significant correlation in decreasing of kinetic stability without visual input, however, it correlated to visual input performed. On the other hand, Colo' study in 2020 agreed to what we revealed that postural stability decreased significantly in the flatfoot group even the muscles activation onset during the transition task of double-to single leg stance did not differ significantly (Koshino, Y., et al., 2020; Sung, P. S., et al., 2017). Ultimately, there was the presence of a slight difference between the GRF to W in subjects in both arch indexes. Finally, flatfoot condition certainly will affect the subject's postural stability. Because a greater amount of force is required to normalize the W vector, postural stability decrease directly.

4.6 Relations of *Pes Planus Plantaris* on the Dynamic Activity on a *Vertical Jump* and *Vertical Jump Loading Response* in Basketball Student-athletes

Assessment of postural stability observed in both dynamic motions revealed similar results as static measurement. It showed decreasing postural stability on student-athletes with *pes planus* compared to the normal arch foot. Sato (2006) studied has noted that dynamic motion analysis in running biomechanics with force plate can determine the direction and magnitude of vGRF. This study indicates that the occurrence of postural instability is caused by the subject's injury experienced in the lower extremities. Sato says that it will lead to abnormal conditions of an anatomical structure in the lower limb plantar structure, namely *pes planus*. Anatomical abnormalities in *plantar pedis* structure due to force and pressure that deliver while initial contactor upon push-off phase (part of a movement vertical jump) in the dynamic activity will produce vertical GRF force 2 to 3 times towards body weight (Handrigan, et al., 2012; Sung, Paul S., 2016). Besides, Karlson (2000) in Hong's (2016) study revealed that the vertical component correlates to the GRF vector (vGRF) deviation standard by using the Berg Balance Scale (BBS) screening tool. It provided an equal value of GRF similar to the force plate examination revealed. What we found, force flat-form posturography (force plate) generated to calculate the association of GRF vector force resultant (vGRF) against basketball student postural stability in static and dynamic conditions.

From what we discovered, the *pes planus plantaris* incident correlated to the subject's postural stability significantly. On dynamic *vertical jump* motion, GRF resultant towards vertical plane generated 15.26 N, causing a decreasing trend of the subject's postural stability. The mean force resultant towards vertical plane force in *pes planus plantaris* was two times higher than normal foot arch subjects. A similar analysis of *pes planus plantaris* athletes also detected higher postural instability during dynamic vertical jump loading response movement. It was proven based on GRF force average resultant to vertical plane forces (W) that vertical jump loading response had a higher instability value rather than vertical jump movement. This theory had a similar finding to Primal (2018) that athlete's postural stability were significantly decreased and disturbed through their postural sway area with the range of center of pressure (CoP) (Primal, et al., 2018).

In this final discussion, we conclude that weight-bearing activities while exercising can increase the incidence of *pes planus plantaris*. It relates to Toullec's (2015) study which declared the pathophysiological occurrence of *pes planus plantaris* on weight-bearing condition. It would continuously disrupt and reduce some supporting structures function in a longitudinal medial arch, especially in the posterior tibial tendon and plantar fascia. As well as in Aydog's (2005) research, *pes planus plantaris* on both lower extremities commonly occur in handball player athletes (such as basketball) with high-level weight-bearing activities. Formation of *pes planus plantaris* will ultimately affect postural stability in basketball student-athletes (Aydog, S T., 2005; Toullec, E., 2015). We would like to emphasize the importance of maintaining plantar arch shape normalities. *Pes planus plantaris* conditions will reduce postural stability which then affects a person's performance in varied activities, especially in athletes which required good performance and excellences during practices and games. We believe this conclusion is related to Bressel et al (2007) and Sung (2015) studies that subjects with flatfoot have greater GRF force threshold than normal arch subjects. The disruption of body stability will affect the athlete's performance. As we noticed, there is very little previous research that analyzes the effect of *pes planus plantaris* on athlete's postural stability, specifically in sports with weight-bearing activities.

5 CONCLUSION

Concluded for about four-fifths of basketball student-athletes in UNJ experienced *pes planus plantaris,* it proved without significant association on both sexes, however, the length of exercise period they performed giving significant correlation. *Pes planus plantaris* associated with decreasing of postural stability range on athletes static, dynamic vertical motion (vertical jump), and dynamic shooting position (vertical jump loading response) conditions.

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