Pristianto A., Nedeputri A.E.S.M., Susilo T.E & Santoso T.B
Fisiomu. 2024, Vol 4(3) : 78-84
DOI : https://10.23917/fisiomu.v5i1.2771

Pilot Study: Different Leg Muscle Activation When Walking on Stable, Unstable & Slippery Floors (Parameters Using Surface Electromyograph)

[1]Arif Pristianto, [1]Anindya Evan Salma Majiid Nadeputri, [1]Taufik Eko Susilo, [1]Totok Budi Santoso
[1]Program Studi Fisioterapi, Fakultas Ilmu Kesehatan, Universitas Muhammadiyah Surakarta

Email : arif.pristianto@ums.ac.id
Tanggal Submisi 09/09/2023 ; Tanggal Penerimaan: 10/01/2024

ABSTRAK

Latar Belakang: Aktivasi otot merupakan interaksi dari cairan sel intraseluler dan cairan sel ekstraseluler yang terjadi pada saluran membran sel dan juga dapat didefinisikan sebagai pergerakan dari kontraksi dan relaksasi otot yang disertai perubahan panjang serabut otot. **Tujuan Penelitian:** untuk mengetahui perbedaan aktivasi otot pada tungkai *(m. gastrocnemius, m. tibialis anterior, m. rectus femoris, m. biceps femoris longum, m. gluteus maximus)* pada saat berjalan diberbagai kondisi laantai/base (stabil, tidak stabil, dan licin) dengan menggunakan *Surface Electromyograph* (sEMG). **Metode Penelitian:** Metode penelitian yang digunakan adalah *Experimental Single Group Design* yang dimana peneliti melibatkan hanya 1 kelompok/grup yang terdiri dari 5 subjek **Hasil Penelitian:** Hasil dari penelitian ini pertama menggunakan uji *Repeated anova* dengan skor nilai yang didapat pada kondisi lantai tidak stabil (0,000), kondisi lantal stabil (0,000) dan kondisi lantai licin (0,000) **Kesimpulan:** Dari hasil penelitian yang sudah dilakukan dapat disimpulkan bahwa ada beda aktivasi otot tungkai saat berjalan pada lantai stabil, tidak stabil dan licin *(Parameter Menggunakan Surface Electromyograph)*.

***Kata kunci**: aktivitas otot, lantai, elektromiografi, sEMG*

ABSTRACT

Background: Muscle activation is the interaction of intracellular cell fluid and extracellular cell fluid that occurs in the cell membrane channel and can also be defined as the movement of muscle contraction and relaxation accompanied by changes in muscle fiber length. **Objective**: to determine differences in muscle activation in the legs (*m. gastrocnemius, m. tibialis anterior, m. rectus femoris, m. biceps femoris longum, m. gluteus maximus) when walking in various floor/base conditions (stable, unstable, and smooth)* using a Surface Electromyograph (sEMG). **Research Methods**: The research method used is Experimental Single Group Design where the researcher involves only 1 group / group consisting of 5 subjects. **Results**: The results of this study first used the repeat ANOVA test with scores obtained on unstable floor conditions (0.000), stable floor conditions (0.000) and slippery floor conditions (0.000). **Conclusion**: From the results of research that has been done, it can be concluded that there are differences in the activation of leg muscles when walking on a stable, unstable and slippery floor (Parameter Using Surface Electromyograph).

***Keywords**: muscle activity, base, electromyograph, sEMG*

ISSN 2722 – 9610
E –ISSN 2722 - 9629

DOI : https://10.23917/fisiomu.v5i1.2771

INTRODUCTION

Walking activities have minimal risks and are relatively easy for everyone to do (Robertson *et al.*, 2012). According to Junaidi (2011), moving movements such as walking are activities that must involve a network in the body and muscle strength in cooling which can allow the muscles to have good resistance to support walking movements and support the entire body weight.

The prevalence of falling according to data from RISKESDAS (2018), states that in Indonesia cases of injury to children in the age range 1-4 years are as much as 8.2%, in adults in the age range 25-34 years there are 7.9% and at the age of 65 years and above reached 8.1%. According to data on the proportion of injuries to the affected body parts, as much as 67.9% occurred in the lower extremities, such as bruises, lacerations, broken bones, and falls.

Fall incidents are included in the category of non-traffic injury incidents. Falls can happen anytime and to anyone without exception, but it is important to know that falls are influenced by two factors, external and internal. External factors include the use of drugs, the footwear worn, and the condition of the floor/base for walking. Meanwhile, internal factors include age, gait, cognitive impairment, and climate muscle strength (Callis, 2016).

The involvement of shivering muscle strength and shivering muscle activation is a major component of human walking (Krogt *et al.*, 2012). Walking activities can be hampered due to weakened cooling muscle activation and loss of muscle strength which can allow falls (Fatmarizka *et al.*, 2023).

Measurement of muscle activation can be measured using the Surface Electromyograph (sEMG) technique. This measurement technique is generally used to detect the activation of muscle groups that are actively involved in an activity. This measurement provides important information in determining which muscles are active and can analyze how much muscle intensity is activated in closing during walking activities such as the 6 closing muscles including m. gastrocnemius, m. tibialis anterior, m. rectus femoris, m. biceps femoris longum, m. gluteus maximus (Muyor *et al.*, 2020).

METHOD

The research method used is experimental single group design, where the researcher involves only 1 group consisting of 5 subjects who meet the inclusion and exclusion criteria, then each respondent will be given the same intervention to walk on 3 floors/stable base, no stable, and slippery randomly by lottery using surface electromyograph (sEMG) measurements.

RESULT

Research Description

The method in this research is using the Experimental Single Group Design method. The subjects of this study were normal individuals who had passed the research screening. This research was conducted based on EC number: 3885/B.2/KEPK-FKUMS/XI/2021, dated 14 December 2021, issued by the Health Research Ethics Commission, Faculty of Medicine, Muhammadiyah University, Surakarta. Data collection starts from the 15th of December 2021 using a questionnaire via Google Form to collect Body Mass Index (BMI) data. In this study, there were 5 subjects who met the inclusion and exclusion criteria who had passed the selection through a questionnaire via Google Form. Research Location at the Muhammadiyah University Gymnasium Laboratory, Surakarta Jalan Ahmad Yani Tromol Pos I Pabelan, Kartasura. Faculty of Health Sciences Universitas Muhammadiyah Surakarta.

Respondent Characteristics Test

The criteria for the respondents in this study were based on the inclusion and exclusion criteria of the study which are described in the following table.

Fisiomu. 2024, Vol 4(3) : 78-84
DOI : https://10.23917/fisiomu.v5i1.2771

Tabel 1. Respondent Characteristics

Respondent Characteristics		
Characteristics	Frequency	Precentage(%)
Age (Years)		
18-19	1	20%
20-21	4	80%
Gender		
Male	5	100%
Female	0	0%

Tabel 2. Respondent's muscle activation in 2 repeated trials

No	Responden	Floor/ stable base					Floor/unstable base					Floor/ slippery base				
		Muscle 1	Muscle 2	Muscle 3	Muscle 4	Muscle 5	Muscle 1	Muscle 2	Muscle 3	Muscle 4	Muscle 5	Muscle 1	Muscle 2	Muscle 3	Muscle 4	Muscle 5
1.	A	2.3	3.26	8.8	**13.2**	10.55	9.22	3.18	10.6	**16.35**	11.05	6.55	3.79	10.8	**16**	11.6
2.	B	1.49	4.08	12.35	**19.95**	13.75	1.58	5.24	13.25	**18.3**	16.25	1.78	4.48	12.6	**22.55**	16.55
3.	C	5.66	**36.8**	13.1	19.6	11.59	6.91	**52.55**	12.3	26.3	12.85	4.64	10.66	10.6	**26.85**	9.13
4.	D	4.91	6.86	5.10	**18.65**	10.14	2.63	5.71	4.7	**22**	10.69	1.64	3.4	4.54	**23.4**	8.5
5.	E	7.09	2.32	**20.95**	7.34	14.8	8.81	3.09	16.1	8.97	**16.75**	5.96	1.80	**17.2**	10.01	11.85

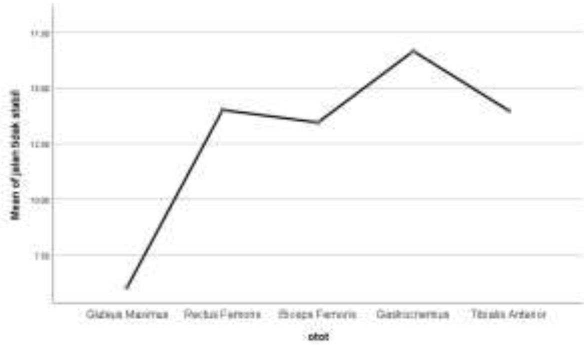
Muscle 1 = Gluteus Maximus, Muscle 2 = Rectus Femoris, Muscle 3 = Biceps Femoris, Muscle 4 = Gastrocnemius, Muscle 5 = Tibialis Anterior

The screening results were carried out before data collection using sEMG, this aimed to fulfill the research inclusion and exclusion criteria. The test on individuals consists of Functional Movement Screening (FMS) which is a measuring tool consisting of 7 movements which aims to assess how much risk an individual has in their functional movements so that the risk of injury to the lower limbs can be anticipated during sports activities (Pristianto *et al.*, 2018). The next measurement is the Berg balance test which is a screening tool to predict the risk of falling at a moderate level of accuracy (Park & Lee, 2017), another advanced test is the Functional Reach Test which is an instrument to assess a person's physical weakness and stability (Mason *et al.*, 2019), and the last is the measurement of the lower limb which includes bone length, true length, and appearance length.

In table 2, shows the average value of muscle activation in each respondent with two repeated trials using sEMG. There is a value indicating an increased level of activation which is indicated by a thick colored shading in the table for each floor/base. In respondents A, B, and D, the muscles that had an increased activation value were M. gastrocnemius on all three floor/base conditions. In Respondent C, the value of increased muscle activation is m. rectus femoris on stable and unstable floors/bases, while on slippery floors/bases activation increases in m. gastrocnemius. Respondent E, increased muscle activation values in M. biceps femoris and m. tibialis anterior.

Based on calculations and results from SPSS from the characteristic tests above, it is known that the muscle that has the highest percentage value in slippery floor conditions is the m muscle.

DOI : https://10.23917/fisiomu.v5i1.2771



Gastrocnemius.**igure 2.** SPSS results of muscle activation on a unstable floor/base

Based on calculations and results from SPSS from the characteristic tests above, it is known that the muscle that has the highest percentage value in unstable floor conditions is m. gastrocnemius.

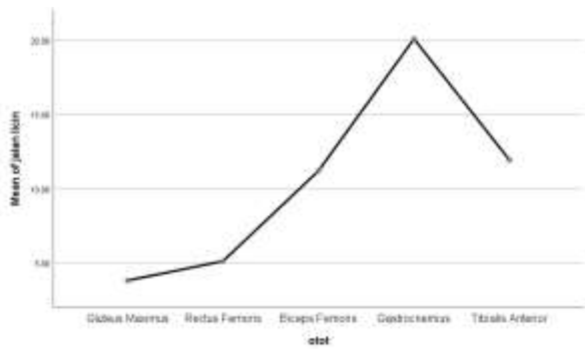


Figure 3. SPSS results of muscle activation on a slippery floor/base

Based on calculations and results from SPSS from the characteristic tests above, it is known that the muscle that has the highest percentage value in slippery floor conditions is M. gastrocnemius.

Normality test

Tabel 3. Shapiro Wilk Normality Test Results

Variabel	p-value	α = 0,05	Keterangan
Unstable	0,000	< 0,05	Abnormal
Slippery	0,003	< 0,05	Abnormal
Stable	0,000	< 0,05	Abnormal
MVIC	0,000	< 0,05	Abnormal

Based on calculations and results from SPSS from the Shapiro Wilk test, it is known that the p-value < 0.05, that is, in unstable road conditions, the Shapiro Wilk score is 0.000, so the data results on unstable roads are 0.00 < 0.05 and are not normally distributed. In slippery road conditions, the Shapiro Wilk score is 0.003, so the data results in slippery road conditions are 0.003 < 0.05, so it can be concluded that the data obtained is not normally distributed. Stable road conditions have a Shapiro Wilk score of 0.000, so the results of the data on stable roads 0.000 <0.05 are not normally distributed. Meanwhile, MVIC has a Shapiro Wilk score of 0.000, so the data results for MVIC 0.000 < 0.05 are not normally distributed.

Repeated Anova Test

In this study, to determine whether there are differences in leg muscle activation when walking on stable, unstable and slippery floors (Parameters using Surface Electromyograph)

Tabel 4. Repeated Anova Test

Variabel	**p-value**	**α = 0,05**	**Keterangan**
Unstable	0,250	> 0,05	No significant effect
Slippery	0,000	< 0,05	Significant effect
Stable	0,017	< 0,05	Significant effect

Based on the SPSS calculations and results from the repeated Anova test above, it is known that the p-value < 0.05, that in unstable road conditions the repeated Anova score is 0.250, so the data results on unstable roads are 0.250 > 0.05 and are not correlated. If slippery road conditions have a Repeated Anova score of 0.000, then the data results for slippery road conditions are 0.000 < 0.05 so it can be concluded that the data that has been obtained has a correlation. Stable road conditions have a repeated ANOVA score of 0.017, so the results of data on stable roads 0.017 <0.05 have a correlation.

DISCUSSION

Respondent Characteristics

M. gastrocnemius involving m. The soleus will produce the main plantar flexor movement in the ankle joint area. M. gastrocnemius is also a strong knee flexor (Noor, 2016). On walks, m. The gastrocnemius was found to increase more on a stable and slippery floor/base during the mid stance phase providing significant propulsive force. activity m. A higher gastrocnemius is needed to control the body and prevent the body from falling during the push off phase (Susilo, 2023).

Differences in leg muscle activation when walking on unstable floors

Activation on m. The gastrocnemius on an unstable floor plays a role in preventing the body from falling forward when walking in the terminal stance phase. m.triceps surae which consists of m. gastrocnemius and m. soleus during this position is active to control dorsiflexion of the foot and as a knee flexor to prevent hyperextension which will then initiate knee flexion. m activation. gastrocnemius on an unstable floor/base may indicate that the biological systems in the lower extremities optimize their work optimally to produce stability when walking (Svenningsen *et al.*, 2019).

Different leg muscle activation when walking on a stable floor.

Activation of muscles in the legs during the stance phase when walking, activation of the hamstring muscles which include m. semimembranosus and m. biceps femoris twice as high as the floor/unstable base. Research shows that the main effect of the walking surface is significant for m activity. gastrocnemius during the mid-stance phase. Another comparison revealed that the activity of m. The gastrocnemius is larger when walking on unstable ground compared to walking on stable ground. activity m. higher gastrocnemius is needed in controlling the body and preventing falls during push-offs and plays a high role in generating power during walking (Jafarnezhadgero *et al.*, 2019).

Different leg muscle activation when walking on a slippery floor

Failure of normal movement and attempts to restore balance after an imbalance leads to problems such as slipping, tripping and even the risk of falling. Muscle activity for the front thighs, hamstrings, especially m. gastrocnemius and m. soleus often occurs on slippery floors. Activity on m. hamstrings have the greatest increase of the lower extremity muscles, while m. The gastrocnemius has the earliest muscle activation during alert movements while walking. Activation of the agonist/antagonist pair of m. gastrocnemius anterior, m. medial tibialis, m. vastus lateralis and m. biceps femoris was found to be larger when on smooth surfaces and individuals had greater contractions while walking (Chander *et al.*, 2021).

CONCLUSION

From the results of research that has been carried out for one week, it can be concluded that the difference in leg muscle activation when walking on unstable walking conditions has a Repeated Anova score of 0.250, so the data results on unstable walking are 0.250 > 0.05 and are not correlated. If slippery road conditions have a Repeated Anova score of 0.000, then the data results for slippery road conditions are 0.000 < 0.05 so it can be concluded that the data that has been obtained has a correlation. Stable road conditions have a score of 0.017 Repeated ANOVA, so the results of the data on stable roads are 0.017 <0.05, there is a correlation. Based on this research, the muscles that have the biggest role when walking are the m muscles. gastrocnemius on stable and slippery road/base conditions. This is m. gastrocnemius involves m. The soleus will produce the main plantar flexor movement in the ankle joint area and is found to increase on a stable and slippery floor/base which is needed to control the body and prevent the body from falling during the push off phase.

It is hoped that the results of the research can be a reference regarding differences in muscle activation in the legs when walking on 3 floors/bases and can provide training programs to improve muscles that have low activation when walking on stable, unstable, and slippery floors/bases. Advice for future researchers is that before conducting research, it is hoped that they first ensure that respondents have met the inclusion and exclusion criteria, and do not have a history of ankle injuries.

REFERENCES

Callis, N. (2016). Falls Prevention: Identification of Predictive Fall Risk Factors. *Applied*

Nursing Research, *29*;53–58. DOI: https://doi.org/10.1016/j.apnr.2015.05.007

Chander, H., Garner, J.C., Wade, C., & Knight, A.C. (2021). Lower Extremity Muscle Activation in Alternative Footwear During Stance Phase of Slip Events. *International Journal of Environmental Research and Public Health*, *18*(4);1–12. DOI: https://doi.org/10.3390/ijerph18041533

Fatmarizka, T., Carissa, V.J.D., & Susilo, T.E. (2023). Spatiotemporal Gait Changes During Pregnancy: A Literature Review. *FISIO MU: Physiotherapy Evidences*, *4*(2);161-168. DOI: https://10.23917/fisiomu.v4i2.22228

Jafarnezhadgero, A.A., Fatollahi, A., Amirzadeh, N., Siahkouhian, M., & Granacher, U. (2019). Ground Reaction Forces and Muscle Activity while Walking on Sand versus Stable Ground in Individuals with Pronated Feet Compared with Healthy Controls. *PLoS ONE*, *14*(9);1–15. https://doi.org/10.1371/journal.pone.0223219

Junaidi, S. (2011). Pembinaan Fisik Lansia melalui Aktivitas Olahraga Jalan Kaki. *Media Ilmu Keolahragaan Indonesia*, *1*(1);17-21. DOI: https://doi.org/10.15294/miki.v1i1.1130

Krogt, V.D.M.M., Delp, S.L., & Schwartz, M.H. (2012). How Robust is Human Gait to Muscle Weakness? *Gait and Posture*, *36*(1);113–119. DOI: https://doi.org/10.1016/j.gaitpost.2012.01.017

Mason, A.N., Lum, J., Milligan, A., & Robinson, J. (2018). Functional Reach Test. *Crit Rev Phys Rehab Med. 29*(1).

Muyor, J.M., Martín-Fuentes, I., Rodríguez-Ridao, D., & Antequera-Vique, J.A. (2020). Electromyographic Activity in the Gluteus Medius, Gluteus Maximus, Biceps Femoris, Vastus Lateralis, Vastus Medialis and Rectus Femoris during the Monopodal Squat, Forward Lunge and Lateral Step-Up Exercises. *PLoS ONE*. *15*(4);1–15. DOI: https://doi.org/10.1371/journal.pone.0230841

Noor, Z. (2016). Gangguan Muskuloskeletal. Jakarta Selatan: Salemba Medika.

Park, S-H. & Lee, Y-S. (2017). The Diagnostic Accuracy of the Berg Balance Scale in Predicting Falls. *Western Journal of Nursing Research*, *39*(11);1502–1525. DOI: https://doi.org/10.1177/0193945916670894

Pristianto, A., Susilo, T.E., & Setiyaningsih, R. (2018). Penerapan Functional Movement Screening (FMS) Untuk Pencegahan Cidera Olahraga Pada Komunitas Kalistenik Solo. *Proceeding of the 8th University Research Colloquium 2018: Bidang MIPA dan Kesehatan*, 267–271. Retrieved from: http://repository.urecol.org/index.php/proceeding/article/view/350

RISKESDAS. (2018). *Hasil Utama Riset Kesehatan Dasar*. Retrieved from: https://kesmas.kemkes.go.id/assets/upload/dir_519d41d8cd98f00/files/Hasil-riskesdas-2018_1274.pdf

Robertson, R., Robertson, A., Jepson, R., & Maxwell, M. (2012). Walking for Depression or Depressive Symptoms: A Systematic Review and Meta-analysis. *Mental Health and Physical Activity*, *5*(1); 66–75. DOI: https://doi.org/10.1016/j.mhpa.2012.03.002

Susilo, T.E. (2023). Effect of Backpack Load on Gait Speed During Walking among University Student: A Pilot Study. *FISIO MU: Physiotherapy Evidences*, *4*(1);78-82. DOI: https://10.23917/fisiomu.v4i1.21401

Svenningsen,F.P., de Zee, M., & Oliveira, A.S. (2019). The Effect of Shoe and Floor Characteristics on Walking Kinematics. *Human Movement Science,* 66;63–72. DOI: https://doi.org/10.1016/j.humov.2019.03.014