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# Correlation between functional mobility and physical activity in elderly with locomotive syndrome

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***Abstract***---Background In the elderly, one of the most common causes of chronic disability is Locomotive syndrome. Locomotive syndrome is a decrease in mobility function due to locomotive organ disorders. Physical activity in the elderly is known to decrease compared to young adults, and good functional mobility is needed to carry out daily physical activities. Objectives To analyze the correlation between functional mobility and physical activity in the elderly with Locomotive syndrome. Methods This study is a cross-sectional observational study. 44 participants (15 men and 29 women) aged 60-78 years participated after screening with the Indonesian version of the Loco-

check questionnaire. Subjects performed the Five Time Sit to Stand (FTSTS) test and filling out the Indonesian version of the International Physical Activity Questionnaire – Short Form (IPAQ-SF). The correlation between FTSTS and IPAQ-SF scores with Loco-check were analyzed using the Spearman correlation test. Results A significant correlation was shown between FTSTS values and Loco-check which yielded with a p value of 0.008, and a correlation coefficient of 0.395. No correlation found between IPAQ-SF scores and Loco-check. Conclusion There is a positive correlation between functional mobility and Locomotive syndrome.

***Keywords***---locomotive syndrome, loco-check, FTSTS, physical activity, IPAQ, elderly.

## Introduction

Over a period of almost 50 years (1971-2018), the percentage of the elderly population in Indonesia has approximately doubled. In 2018, the percentage of the elderly reached 9.27 percent or around 24.49 million people[1]. According to the Central Statistics Agency the life expectancy of the Indonesian population continues to increase. When classified by age, the age category 15-64 years old is projected to increase from 67.3 to 68.1 percent and those aged 65 years old and over are projected to increase from 8.49 to 13.82 percent in the period of 2015-2030. From these projections, it is predicted that the number of elderly people in 2030 would be 40.95 million[2,3].

One disorder that occurs in the elderly is Locomotive syndrome (LS), which is defined as a decrease in mobility caused by weakness of the locomotive organs[4]. This syndrome is one of the most common causes of chronic disability in the elderly population. In Japan, 5.5 million individuals between 40-70 years old suffer from LS. The average prevalence of LS is 10.2%[5]. The number of patients with LS is equivalent to patients suffering osteoarthritis (OA) or osteoporosis. As many as 25% of patients aged over 40 years old suffer from a progressive decrease in mobility and increases exponentially after age 70 years old[4]. In Indonesia, the prevalence of knee OA reaches 15.5% in men and 12.7% in women. It is estimated that 1-2 million elderly people in Indonesia suffer from disabilities due to OA[6].

Conditions such as OA and osteoporosis can cause mobility impairments in elderly patients[6]. Simple field tests are often used to assess functional mobility in a clinical setting[7,8]. Functional mobility is a term used to describe balance condition and walking activity in daily life (i.e. sitting, standing, walking, turning around)[9]. The use of functional mobility tests remains popular tests used to assess in the clinical and elderly population[7,8]. Five Time Sit To Stand (FTSTS) test is one that is often used, which could assess mobility function and risk of falls in elderly groups[10,11].

There is evidence to suggest that losses in functional mobility could be prevented in many older persons through physical activity (PA)[12]. Doing physical activities at a minimum level per day in correct way could bring a good impact on overall

health[13]. PA is defined by the American College of Sports Medicine and the Centers for Disease Control and Prevention as any bodily movement caused by skeletal muscle contraction that results in a substantial increase in energy output at rest[14,15]. Physical activities based on their type, could be categorized into working, walking, and leisure time[16]. PA data around the world vary widely. A study on the number of footsteps from 47 countries[17] revealed that Hong Kong is the country with the most individual footsteps, while Indonesia is the fewest. If PA measurement was not carried out properly, it could obscure the detection of the important relationship and effects of PA[18]. The most frequently used PA assessment method in population-based cohort studies and surveillance systems is the questionnaire[19]. The International Physical Activity Questionnaire (IPAQ) is the most widely used and has been validated in various countries[18]. The International Physical Activity Questionnaire – Short Form (IPAQ-SF) is an examination tool that can be used to determine the number of daily activities. This questionnaire could measure the amount of PA of an individual in the past week, and determine the individual's PA level[20]. In Indonesia, research on functional mobility and PA in the elderly is still limited, while research on LS are only a few. Based on this phenomenon, this study aims to analyze the correlation between functional mobility and PA in elderly with LS.

## Methods

This study is a cross sectional observational study. Participants were Indonesian elderly adults at the community health services for the elderly (*Posyandu Lansia*) in Rungkut Barata, Surabaya, Indonesia. Participants were selected by consecutive sampling in October 2020. Inclusion criteria were Indonesian males and females aged 60 years old and above which were screened for LS using the Indonesian version of the Loco-check, could read and answer questionnaires in Indonesian language. Individuals were excluded if having any uncorrected eyesight disorders, hearing disorders, cognitive disorders, or heavy cardiopulmonary disorders. 44 participants with LS were identified and recruited to partake in this study. Age, sex, height, weight and body mass index (BMI) were recorded. All participants provided written informed consent and the study protocol was approved by the Health Research Ethics Committee of the Faculty of Medicine of Universitas Airlangga.

LS was assessed and screened by using the Indonesian version of the Loco-check, which had previously been adapted for cross-cultural adaptation to Indonesian language[21,22]. The Loco-check consists of a 7-item questionnaire to assess locomotive disability based on activities of daily living. Participants were considered as having LS if at least one of the seven items was answered yes[21]. Loco-check was self-completed by the participants. Functional mobility was examined using the FTSTS test. The test measures in seconds, the time it took for a person to get up from a chair and sit back down five times, as quickly as possible. Subjects did 1-2 trial tests before the actual test. The actual test was performed twice and the average time was recorded as the final measurement. The chair used is a standard chair (approximately 46 cm in height) with an upright backrest. Subjects wear ordinary footwear and arms are folded in front of their chest during the whole test[10,23]. Vital signs were examined before and after the test. No physical assistance was provided. PA was evaluated using the

Indonesian version of the IPAQ-SF which had been previously adapted for cross-cultural adaptation to the Indonesian language[24]. The IPAQ-SF assesses the amount of PA in the last 7 days, recording the duration of daily activities of vigorous-intensity activity, moderate-intensity activity, walking, and sitting of each participant. Results were recorded as MET-min/week and participants were classified in three categories, low, moderate, and high PA[20].

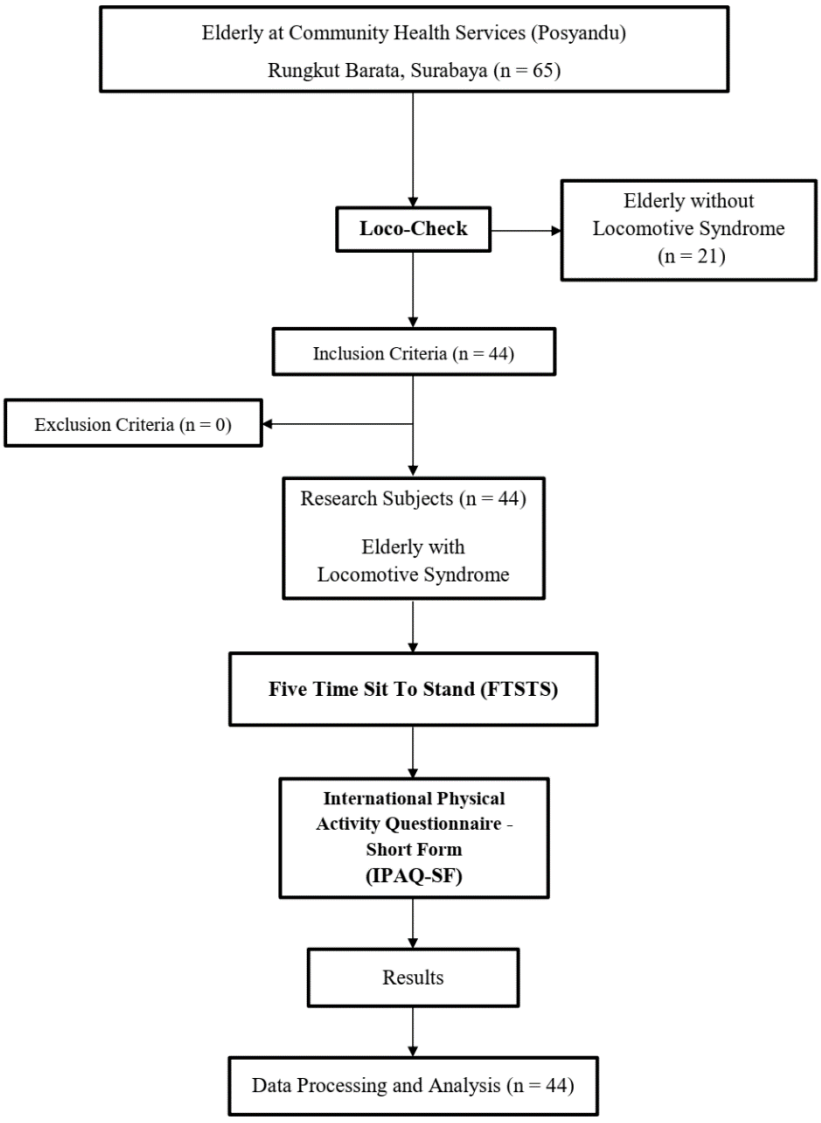


Figure 1. Research Flow

**Statistical analysis**

The data collected were analyzed using SPSS v26.0. Data were tested for normal distribution with the Shapiro Wilk test. Non parametric Spearman's correlation

test was used to analyze correlation outcomes. Results were significant if $p < 0.05$.

**Results**

The total research subjects who met the inclusion criteria with LS were 44 people, consisting of 15 men and 29 women as seen in table 1. Research subjects were assessed for their base characteristics i.e age, weight, height, and body mass index. Characteristics of research subjects could be seen in table 2.

Table 1
Percentage of research subjects based on gender

| Gender | Total Subjects (n = 44) |
|---|---|
| Male | 15 (34.09 %) |
| Female | 29 (65.91 %) |
| Total | 44 (100 %) |

Table 2
Characteristics of research subjects

| | Mean (SD) | Minimum value | Maximum value |
|---|---|---|---|
| Age (Years) | 67.7 (4,7) | 60 | 77 |
| Body weight (kg) | 61.7 (11,9) | 33.9 | 87.8 |
| Body height (cm) | 1.56 (0,08) | 1.38 | 1.80 |
| Body Mass Index (kg/m²) | 25.23 (4,41) | 15.07 | 33.69 |
| IPAQ-SF scores (MET-min/week) | 1,873 (2.011) | 0 | 9,732 |
| FTSTS (sec) | 13.47 (4,80) | 7.00 | 30.00 |

Grouping results of the individual FTSTS scores of subjects, the majority had poor FTSTS performance, while subjects with good FTSTS performance were only limited to 18 people as seen in table 3.

Table 3
Classification of FTSTS of research subjects

| | Total Subjects (n = 44) |
|---|---|
| FTSTS | |
| Good performance | 18 (40.9%) |
| Poor performance | 26 (59.1%) |

PA levels of the research subjects based on the IPAQ-SF were divided into 3 categories, low, medium, and high PA. The average PA of research subjects was categorized as moderate PA. The majority of subjects were also categorized as moderate level of PA based on their individual IPAQ-SF scores, while subjects categorized with low and high levels of PA were fewer and of equal amount, as seen in table 4.

Table 4
Level of physical activity of research subjects

| | Total Subjects (n = 44) |
|---|---|
| Physical Activity Category (IPAQ-SF) | |
| Low | 11 (25%) |
| Moderate | 22 (50%) |
| High | 11 (25%) |

The normality test of the FTSTS test showed values that were not normally distributed (*p* value < 0.05), hence non-parametric Spearman's correlation test was used. The correlation test between functional mobility based on the FTSTS scores and LS based on the total number of yes answered in the Loco-check resulted in a significant value, with a level of correlation categorized as low (0.395), which concludes that there is a correlation between functional mobility and LS. The correlation test between FTSTS and the Loco-check can be seen in table 5. The normality test of the IPAQ-SF score showed values that were not normally distributed (*p* value < 0.05), hence non-parametric Spearman's correlation test was also used. The correlation test between PA based on IPAQ-SF scores and LS based on the total number of yes answered in the Loco-check yielded no significant value, which concludes that there is no correlation between PA and LS. The correlation test between IPAQ-SF and the Loco-check can be seen in table 5.

Table 5
Correlation between FTSTS and IPAQ-SF with the Indonesian version of the Loco-check questionnaire on research subjects

| | Loco-check (n = 44) Correlation coefficient | *p* value |
|---|---|---|
| FTSTS | 0.395 | 0.008 * |
| IPAQ-SF | - 0.049 | 0.752 |

* Spearman's correlation test were significant if *p* value < 0.05.

**Discussion**

The data of the current study shows that LS in women is more prominent than men, which is in accordance with research of Kimura *et al*[5]. They conducted an internet survey study using the Geriatric Locomotive Function Scale-25 (GLFS-25) on subjects aged 40-79 years old and obtained a higher mean score in group of women than in men, and also found a higher prevalence of LS in the elderly over 70 years of age when compared to the age group under 70 years. This can be due to the fact that in Japan the female population has a life expectancy of up to 86 years, which is higher than that of men, which is 79 years[25]. Similarly Ohtsuki *et al.*[26] examined subjects aged 18-64 years old at various companies in Japan, which showed a higher risk of LS at the age of 45 years old and over, and women having higher risk of LS. In the current study, it could be estimated that the population with LS is quite large in Indonesia since the elderly population in 2020

is approximately 26.82 million people, with a higher percentage of elderly women (52.29%) than men[27].

Characteristics of subjects in the form of weight, height, and BMI have been obtained in the current study with homogeneous values. The average BMI of subjects was 25.23 kg/m2, while average height was 1.56 meters. Comparing to data from Nakamura *et al.*[4], that study explained the relationship between height and BMI with LS in the elderly female population in Japan, which subjects with LS had lower height than subjects without LS, additionally it revealed that LS subjects had a higher BMI with a limit value of 23.5 kg/m2. It was explained that BMI is one of the indicators that can detect LS[4]. In our current study, the average height of subjects were similar to data from Nakamura *et al.*[4] (1.50 meters), and our subjects had an average BMI above the limit value. Similarly, Mitani *et al.*[28] also researched that BMI in the LS group was higher than without LS. What distinguishes that research is the population was aged 40-74 years old. That study also included conditions for metabolic syndrome disorders other than LS. Both LS groups with and without combined metabolic syndrome showed a higher average BMI than the group without LS[28], although this value was lower than the BMI limit set by Nakamura *et al.*[4]

Bohannon[29] analyzed the estimated normal value of FTSTS in individuals aged 60 years old and over. The meta-analysis estimated normal performance of FTSTS in individuals over 60 years old, stratified by 10-year age groups (60-69, 70-79, and 80-89). The estimated normal FTSTS value in the 60-69 year age range is 11.4 seconds, 70-79 year age group is 12.6 seconds, and 80-89 year age group is 14.8 seconds. FTSTS scores exceeding the normal value indicated poorer performance than the average population. When grouped with individuals over 60 years of age, the value was not homogeneous and the average FTSTS value is 12.1 seconds[29]. In our current study, the average FTSTS obtained from subjects was 13.47 seconds. Comparing to Bohannon's results[29], average FTSTS of our subjects exceeds the normal estimated value. Subjects in our study based on age groups performed worse than in Bohannon's study, which indicated impaired functional mobility.

Average FTSTS in our subjects showed a longer FTSTS time, which is similar from Taniguchi *et al.*[30] which showed a shorter FTSTS time in subjects without LS, but assessment of LS in that study used the GLFS-25. Although our study used the Loco-check, results were in accordance with the study of Taniguchi *et al.*[30] which concluded a poorer functional mobility in subjects with LS. Yoshimura *et al.*[31] also assessed FTSTS in subjects with and without LS, but with subjects ranging from young adults to the elderly. FTSTS value in that study stated a decrease in functional mobility which was described with a longer FTSTS time (> 12 seconds) and slow walking speed[31]. However, that study also assessed LS using GLFS-25[31]. Comparing those two studies with ours, there is a similarity in the tendency of the FTSTS to be performed slower in subjects with LS which indicates a decrease in mobility function.

Correlation test between functional mobility using FTSTS and LS using the Indonesian version of the Loco-check resulted in a significant value with a low level correlation. Comparing to research done by Yoshimura *et al.*[31], that study

examined the FTSTS against several LS risk indicators (two step test, one leg stand test, and GLFS-25) of subjects aged 40 years old and over, with results of the odds ratio between the value of a slow performance FTSTS (>12 seconds) against LS risk indicators, which increased with each indicator accumulation. Although that study did not directly test the correlation between FTSTS and LS, it concluded that the risk indicators for LS had an impact on the slow performance FTSTS values indicating a decrease in functional mobility[31]. Further, the research done by Taniguchi *et al.*[30] resulted in slower FTSTS performance as the severity of LS was increased. However that study did not specifically test the correlation between FTSTS and LS, but only compared FTSTS values in subjects with different LS severities, and used the GLFS-25. Hence both studies support the current study of a significant correlation between functional mobility using FTSTS and LS using the Indonesian version of the Loco-check, even though a low level correlation was obtained.

Based on the IPAQ-SF scores of the current study, 11 subjects were categorized to low PA and an equal amount categorized to high PA, but the majority were 22 subjects categorized to moderate PA. Comparing to a study by Meisner *et al.*[32] which involved a survey on PA of 130,000 participants aged 60 years old and over in Canada based on the Canadian Community Health Survey, the majority were inactive PA respondents (53.8%), while moderate and active PA were respectively only 24.9% and 21.3%. Another study was by Santoso *et al.*[33] which assessed the PA of elderly participants in Bantul, Indonesia using the Self-reporting of Physical Activity Questionnaire, categorizing into adequate and inadequate PA. That study showed the majority of subjects with adequate PA (55.8%)[33]. If those two studies were compared to ours, the number of our subjects classified as having adequate PA, namely with moderate and high PA reaches 75%, which would be in line with the study by Santoso *et al.*[33] while contrary to study by Meisner *et al.*[32] We suspect this could be due to differences in culture and habits of the Indonesian and Canadian elderly people.

Additionally, research done by Tomioka *et al.*[34] explained that the total IPAQ of elderly men was higher than that of elderly women, with an average of 2,170 MET-min/week for men, and 1,320 MET-min/week for women. In that study, the average IPAQ score was similar to our current study, and indicated that most of the research subjects carried out moderate-intensity PA[34]. Although those studies did not take into account the presence of LS, another comparison would be the research done by Ohtsuki *et al.*[26] comparing subjects with and without LS. That study stated PA was higher in subjects without LS. That study assessed PA using the University of California Los Angeles 10-point activity level scale with subjects ranging young adults to middle-aged adults[26]. Since in our current study we did not compare PA on subjects without LS, we would be unable to know for sure if PA in LS subjects would be higher than those without LS, though the majority of subjects still had moderate to high levels of PA. Otani *et al.*[35] on the other hand took subjects from the Locomotive Syndrome and Health Outcome in Aizu Cohort Study (LOHAS) with subjects aged 40 years old and over.

PA level of subjects from that study was assessed using the IPAQ and were classified into low, medium and high PA levels, differentiated between men and women. The result of that study showed that subjects with high level of PA were

greater than those with moderate or low level PA. The percentage of subjects with high PA level also increases with older age compared to subjects aged 40-50 years old. That study did not compare the intensity of PA for subjects with LS and without LS, but the percentage of subjects who had risk of LS in the form of OA and disorders of the spine or low back pain was around 30-50% of the total participants (3,243 subjects)[35]. Compared to the current study, the majority of subjects were categorized as moderate to high levels of PA which would still be in line with the study by Otani *et al.*[35]

The correlation test between PA using IPAQ-SF and LS using the Indonesian Loco-check resulted in a non-significant value. At the time of writing, there is no research known to the author that explains the correlation between the IPAQ-SF and the Loco-check. However, Kitada *et al.*[36] examined the relationship between PA using the IPAQ-SF and the GLFS-25 to determine the severity of LS in the elderly after walking and climbing stairs for 3 months, and found that PA was not significantly correlated with the severity of LS. Though there was an increase in PA but the changes in the GLFS-25 score and the two-step test had no significant effect on the severity of LS[36]. This fits with results of the current study. In contrast, research by Hirano *et al.*[37] described the relationship between quality of life using Short Form 36 (SF-36) and the influence of LS using Loco-check. The value of the 10 sections of SF-36 including physical functioning (limitation of physical activity), is negatively correlated with LS in that study, stating that subjects with LS have greater PA limitations than those without LS[37].

This is in contrast to our research and Kitada *et al.*[36] The differences in results could possibly due to the use of IPAQ-SF in our study, since each subject gave subjective answers on duration of vigorous and moderate physical activities, walking and sitting per day for the past week. It could be possible these questions could not be calculated properly by the participants and resulted in an IPAQ-SF score that is either too low or too high. Another possibility is that examples of activities written in the IPAQ-SF describing vigorous and moderate physical activities, did not reflect the activities undertaken by the participants. While the SF-36, consists of 36 questions regarding quality of life, but only 10 questions examine physical functioning (limitation of PA), additionally only 2 of the 10 questions regarding limitations of heavy and moderate PA, while 8 other questions specifically concern the limitations in physical activities (i.e. carrying shopping bags, distance climbing up the stairs, bending or squatting position, walking distance, and bathing or dressing activities). These possibilities could explain the seemingly wide standard deviation value of the average IPAQ-SF score of our subjects. The author considers further research in PA of elderly LS subjects could be explored with different methods.

**Conclusion**

In conclusion, our current study showed a significant correlation between functional mobility based on FTSTS and LS based on Loco-check, but no correlation was found between between PA based on IPAQ-SF and LS based on Loco-check. Therefore the author suggests that FTSTS could be used as a screening tool for risk of LS. Limitations of this study include that IPAQ-SF scores reflect subjectively the research subjects' response on daily activities which could

impact on IPAQ-SF scores, and did not take into account correlation to each question of the Loco-check. Additionally only the elderly population was assessed and did not take into account of comorbidities found on research subjects. Recommendations for further research include the need to conduct research on correlation between IPAQ-SF scores based on PA levels and with each question of the Loco-check. Furthermore, IPAQ-SF scores could be more objectively if incorporated with other techniques such as diary of daily activities with METs score, or the use of objective measurements (i.e. pedometers, accelerators) on daily activities. We would also suggest further research on more varied age subject groups and therefore results could be generalized to reflect the population as a whole. Account on comorbidities (i.e. cardiopulmonary, metabolic and BMI problems) of research subjects would also be further explored to recognize its effect on functional mobility, PA, and LS.

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**Conflict of interest**

The authors declare no conflict of interest regarding the publication of this paper.

**References**

1. Abasmay, F., Nugraheni S, N., & Masduchi, R. H. (2020). Association between Fear of Falling, Balance and Functional Mobility in the Elderly. *Indian Journal of Forensic Medicine & Toxicology*, 14(2).
2. Al Hayyan, A. J., Wulan, S. M. M., Masduchi, R. H., Nugraheni, N., Poerwandari, D., Melaniani, S., Mikami, Y., & Tajima, F. (2021). Validity and reliability of the loco-check questionnaire after cross-cultural adaptation for Indonesia. *Journal of Orthopaedic Science*.
3. Alcivar, M. S. G., Pérez, A. V., Gilert, B. I. C., & Gámez, M. R. (2017). Zeolite in wastewater decontamination as a local development solution. International Journal of Life Sciences, 1(3), 1–13. https://doi.org/10.21744/ijls.v1i3.52
4. Althoff, T., Sosič, R., Hicks, J. L., King, A. C., Delp, S. L., & Leskovec, J. (2017). Large-scale physical activity data reveal worldwide activity inequality. *Nature*, 547(7663), 336-339.
5. Badan Pusat Statistik. (2013). Proyeksi Penduduk Indonesia 2010-2013. Jakarta Pusat: *Badan Pusat Statistik*.
6. Badan Pusat Statistik. (2018). Statistik Penduduk Lanjut Usia. Jakarta Pusat: *Badan Pusat Statistik*.
7. Badan Pusat Statistik. (2020). Statistik Penduduk Lanjut Usia. Jakarta Pusat: *Badan Pusat Statistik*.
8. Bohannon, R. W. (2006). Reference values for the five-repetition sit-to-stand test: a descriptive meta-analysis of data from elders. *Perceptual and motor skills*, 103(1), 215-222.
9. Booth, F. W., Roberts, C. K., & Laye, M. J. (2012). Lack of exercise is a major cause of chronic diseases. *Comprehensive physiology*, 2(2), 1143.

10. Dharmansyah, D., & Budiana, D. (2020). Indonesian Adaptation of The International Physical Activity Questionnaire (IPAQ): Psychometric Properties. *Jurnal Pendidikan Keperawatan Indonesia*, 7(2).
11. Hickey, T., Wolf, F. M., Robins, L. S., Wagner, M. B., & Harik, W. (1995). Physical activity training for functional mobility in older persons. *Journal of Applied Gerontology*, 14(4), 357-371.
12. Hirano, K., Imagama, S., Hasegawa, Y., Ito, Z., Muramoto, A., & Ishiguro, N. (2013). The influence of locomotive syndrome on health-related quality of life in a community-living population. *Modern rheumatology*, 23(5), 939-944.
13. IPAQ Research Committee. (2004). Guidelines for Data Processing and Analysis of the International Physical Activity Questionnaire (IPAQ) - Short Form. *IPAQ Research Committee*.
14. Ishibashi, H. (2018). Locomotive syndrome in Japan. *Osteoporosis and sarcopenia*, 4(3), 86-94.
15. Kementrian Kesehatan RI. (2017). Analisis Lansia di Indonesia. Jakarta Selatan: *Kementrian Kesehatan RI.*
16. Kimura, A., Seichi, A., Konno, S., Yabuki, S., & Hayashi, K. (2014). Prevalence of locomotive syndrome in Japan: a nationwide, cross-sectional Internet survey. *Journal of Orthopaedic Science*, 19(5), 792-797.
17. Kitada, T., Ozaki, H., Nakagata, T., Ishibashi, M., Machida, S., & Naito, H. (2016). Relationship Between Physical Activity and Locomotive Syndrome After a 3-Month Exercise Intervention of Walking and Stair Climbing in Elderly Japanese Individuals. Juntendo Medical Journal, 62(Suppl. 1), 218-224.
18. Lin, S. I., Lee, H. C., Chang, K. C., Yang, Y. C., & Tsauo, J. Y. (2017). Functional mobility and its contributing factors for older adults in different cities in Taiwan. *Journal of the Formosan Medical Association*, 116(2), 72-79.
19. Maulida, M. N., Lubis, L., & Sari, D. M. (2017). Physical Activity Profile Of The Professors Of Padjadjaran University Based On Global Physical Activity Questionnaire. *Folia Medica Indonesiana*, 53(4), 283–286.
20. Medina-Mirapeix, F., Vivo-Fernández, I., López-Cañizares, J., García-Vidal, J. A., Benítez-Martínez, J. C., & del Baño-Aledo, M. E. (2018). Five times sit-to-stand test in subjects with total knee replacement: Reliability and relationship with functional mobility tests. *Gait & posture*, 59, 258-260.
21. Meisner, B. A., Dogra, S., Logan, A. J., Baker, J., & Weir, P.L. (2010). Do or decline? Comparing the effects of physical inactivity on biopsychosocial components of successful aging. *Journal of health psychology*, 15(5), 688-696.
22. Mitani, G., Nakamura, Y., Miura, T., Harada, Y., Sato, M., & Watanabe, M. (2018). Evaluation of the association between locomotive syndrome and metabolic syndrome. *Journal of Orthopaedic Science*, 23(6), 1056-1062.
23. Mong, Y., Teo, T. W., & Ng, S. S. (2010). 5-repetition sit-to-stand test in subjects with chronic stroke: reliability and validity. *Archives of physical medicine and rehabilitation*, 91(3), 407-413.
24. Nakamura, K. (2011). The concept and treatment of locomotive syndrome: its acceptance and spread in Japan. *Journal of Orthopaedic Science*, 16, 489–491.
25. Nakamura, K. (2016). Locomotive Syndrome: Definition and Management. *Clinical Reviews in Bone and Mineral Metabolism*, 14, 56–67.
26. Nawangasri, A. P., Budiono, B., Bakhtiar, A., Sutikno, B., Suryaningrum, E. M., & Damayanti, D. (2022). The Relationship between Physical Activity and

FEV1/FVC in Asthmatics. *Surabaya Physical Medicine and Rehabilitation Journal*, 4(1), 1-6.
27. Northgraves, M. J., Hayes, S. C., Marshall, P., Madden, L. A., & Vince, R. V. (2016). The test-retest reliability of four functional mobility tests in apparently healthy adults. *Isokinetics and Exercise Science*, 24(3), 171-179.
28. Ohtsuki, M., Nishimura, A., Kato, T., Sokejima, S., Shibata, T., Okada, H., Nagao-Nishiwaki, R., & Sudo, A., (2019). Relationships between body mass index, lifestyle habits, and locomotive syndrome in young-and middle-aged adults: a cross-sectional survey of workers in Japan. *Journal of occupational health*, 61(4), 311-319.
29. Otani, K., Takegami, M., Fukumori, N., Sekiguchi, M., Onishi, Y., Yamazaki, S., Ono, R., Otoshi, K., Hayashino, Y., Fukuhara, S., & Kikuchi, S. I. (2012). Locomotor dysfunction and risk of cardiovascular disease, quality of life, and medical costs: design of the Locomotive Syndrome and Health Outcome in Aizu Cohort Study (LOHAS) and baseline characteristics of the study population. *Journal of Orthopaedic Science*, 17(3), 261-271.
30. Pescatello, L. S., Riebe, D., & Thompson, P. D. (Eds.). (2013). ACSM's guidelines for exercise testing and prescription. *Lippincott Williams & Wilkins*.
31. Peter, V. F. (2015). Relationship among culture, education and sports. International Research Journal of Management, IT and Social Sciences, 2(11), 38-42. Retrieved from https://sloap.org/journals/index.php/irjmis/article/view/326
32. Santoso, N. K., Thongpat, S., & Wattanakul, B. (2015). Predictors of Physical Activity in Older People with Hypertension, Bantul, Indonesia. *Journal of Health Research*, 29(Suppl. 1), S7-S13.
33. Schaubert, K. L., & Bohannon, R. W. (2005). Reliability and validity of three strength measures obtained from community-dwelling elderly persons. *Journal of strength and conditioning research*, 19(3), 717.
34. Soeroso, J., Isbagio, H., Kalim, H., Broto, R., & Pramudiyo, R. (2014). Osteoartiritis. Buku Ajar Ilmu Penyakit Dalam Jilid III Edisi VI. Jakarta: FKUI Pusat, 3197-3209.
35. Steene-Johannessen, J., Anderssen, S. A., Van der Ploeg, H. P., Hendriksen, I. J., Donnelly, A. E., Brage, S., & Ekelund, U. (2016). Are self-report measures able to define individuals as physically active or inactive?. Medicine and science in sports and exercise, 48(2), 235.
36. Taniguchi, M., Ikezoe, T., Tsuboyama, T., Tabara, Y., Matsuda, F., & Ichihashi, N. (2021). Prevalence and physical characteristics of locomotive syndrome stages as classified by the new criteria 2020 in older Japanese people: results from the Nagahama study. *BMC geriatrics*, 21(1), 1-10.
37. Tomioka, K., Iwamoto, J., Saeki, K., & Okamoto, N. (2011). Reliability and validity of the International Physical Activity Questionnaire (IPAQ) in elderly adults: the Fujiwara-kyo Study. *Journal of epidemiology*, 1109210254-1109210254.
38. van Poppel, M. N., Chinapaw, M. J., Mokkink, L. B., Van Mechelen, W., & Terwee, C. B. (2010). Physical activity questionnaires for adults. *Sports medicine*, 40(7), 565-600.
39. Widana, I.K., Sumetri, N.W., Sutapa, I.K., Suryasa, W. (2021). Anthropometric measures for better cardiovascular and musculoskeletal health. *Computer Applications in Engineering Education*, *29*(3), 550–561. https://doi.org/10.1002/cae.22202

40. Yoshimura, N., Muraki, S., Oka, H., Tanaka, S., Ogata, T., Kawaguchi, H., Akune, T., & Nakamura, K. (2015). Association between new indices in the locomotive syndrome risk test and decline in mobility: third survey of the ROAD study. *Journal of orthopaedic science*, 20(5), 896-905.