


Diagnosis of Sarcopenia in Geriatrics using Actigraph wGT3XBT Accelerometer: A Narrative Review

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ABSTRACT

Sarcopenia is a degenerative condition of age-related decline in muscle mass and strength. The worldwide occurrence of sarcopenia varied from 8% to 36% in those under the age of 60, and from 10% to 27% in those aged 60 and above. There is 9.92% or around 26.82 million, elderly people in Indonesia. Several studies have stated that in 2020, the incidence of sarcopenia in Indonesia ranged from 9.1% to 59%. Various studies have shown that accelerometers can provide a quantitative measurement of physical activity, positively correlated with muscle mass and strength in the elderly. Accelerometers, particularly the Actigraph wGT3X-BT, offer an objective approach to measuring physical activity and provide important insights into sarcopenia. Accelerometers offer an unbiased method for quantifying physical activity, offering valuable information on sarcopenia, and serving as a clinical diagnostic tool for this disorder characterized by reduced muscle mass and function. Literature review suggests that the Actigraph wGT3X-BT accelerometer has great potential for early detection and diagnosis of sarcopenia. The integrated use of this technology is expected to improve the accuracy of diagnosis and enable more effective interventions, thereby improving the quality of life of the elderly in Indonesia.

Keywords: Accelerometer, Actigraph wGT3X-BT, elderly, sarcopenia.

ABSTRAK

Sarkopenia adalah kondisi degeneratif penurunan massa dan kekuatan otot berkaitan dengan usia. Prevalensi sarkopenia di seluruh dunia bervariasi antara 8% hingga 36% pada individu berusia di bawah 60 tahun, dan antara 10% hingga 27% pada individu berusia 60 tahun ke atas. Terdapat 9,92% atau sekitar 26,82 juta orang lanjut usia di Indonesia. Beberapa studi telah menyatakan bahwa pada tahun 2020, insiden sarkopenia di Indonesia berkisar antara 9,1% hingga 59%. Berbagai penelitian telah menunjukkan bahwa akselerometer dapat memberikan pengukuran kuantitatif aktivitas fisik, yang berkorelasi positif dengan massa dan kekuatan otot lanjut usia (lansia). Akselerometer, khususnya Actigraph wGT3X-BT, menawarkan pendekatan objektif untuk mengukur aktivitas fisik dan memberi wawasan penting tentang sarkopenia. Akselerometer menggunakan metode yang objektif untuk mengukur aktivitas fisik, memberikan informasi mengenai sarkopenia, dan berfungsi sebagai alat diagnostik klinis yang ditandai dengan berkurangnya massa otot dan fungsi otot. Hasil tinjauan literatur menunjukkan bahwa Akselerometer *Actigraph* wGT3X-BT memiliki potensi besar untuk deteksi dan diagnosis dini sarkopenia. Penggunaan teknologi ini secara terintegrasi diharapkan dapat meningkatkan akurasi diagnosis dan memungkinkan intervensi yang lebih efektif, sehingga dapat meningkatkan kualitas hidup lansia di Indonesia. **Fatmanur Hurulhanifa, Nimas Adiani Sekar Laranti, Hanifa Nur Shabrina, Norina Agatri, Gembong Satria Mahardhika. Diagnosis Sarkopenia pada Geriatri Menggunakan Akselerometer Actigraph wGT3XBT: Tinjauan Naratif.**

Kata Kunci: Akselerometer, Actigraph wGT3X-BT, lanjut usia, sarkopenia.

Introduction

The aging process is associated with functional changes; increasing age is followed by decrease in muscle mass and bone mass. Changes related to the aging process occur after 50 years of life. These changes are significant as loss of 1%-2% of body mass each year and a decrease in strength of 1.5%–5% each year.[1] Sarcopenia refers to the age-related degenerative condition characterized by a decline in muscle mass and strength. While the term "sarcopenia" was first used in 1989, a realistic clinical definition of sarcopenia was developed in 2010 by the European Working Group on Sarcopenia in Older People (EWGSOP).[2] Sarcopenia, as defined by EWGSOP, is a syndrome characterized by a progressive decline in muscle mass and strength, which poses a risk of problems including physical disability, diminished quality of life, and mortality.[3] The prevalence was determined in Oceania and Europe using the EWGSOP and EWGSOP2 criteria. The worldwide occurrence of sarcopenia varied from 8% to 36% in those under the age of 60, and from 10% to 27% in those aged 60 and above. According to the EWGSOP2 criteria, males had a higher proportion of sarcopenia (11% in males and 2% in females); however, according to the International Working

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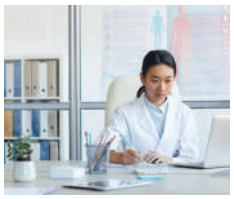
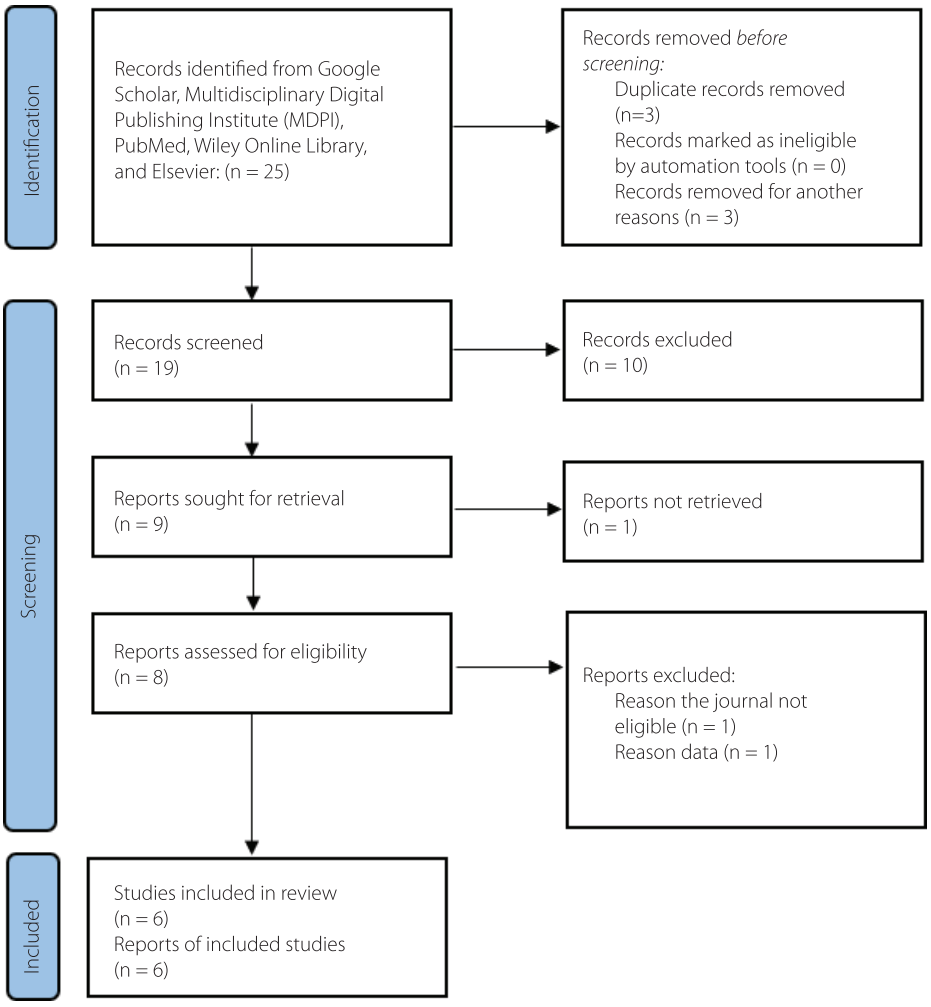


Group on Sarcopenia criteria, females had a higher prevalence (17% in females and 12% in males). Ultimately, the prevalence of severe sarcopenia ranges from 2% to 9%.[4] The Asian Working Group of Sarcopenia (AWGS) criteria indicate that the prevalence of sarcopenia in the aged population is 9.1%.[5]

According to the Ministry of Health (Kemenkes) in 2019, Indonesia entered Indonesia Towards an Aging Population, an increase in life expectancy followed by an increase in the elderly population. Decreased muscle mass and muscle strength are additional problems with high prevalence in elderly individuals. There are 9.92% or around 26.82 million elderly people in Indonesia.[6] Several studies have stated that in 2020, the incidence of sarcopenia in Indonesia ranged from 9.1% to 59%.2,[3] A study on 386 elderly people in Indonesia indicated that sarcopenia was found in 17.6% individuals.[7]

Approximately 20% older individuals in Indonesia experience sarcopenia, a condition that is linked to being female, having limited functional capacity, and a previous history of falls.[8] Determining sarcopenia is challenging, mostly because of variations in age limitations, diagnosing methods, and gender. Research on sarcopenia in Indonesia is scarce. Accelerometers are valuable instruments for quantitatively assessing physical activity, sleep disruptions, gait, balance, and vital signs. Accelerometers offer an unbiased method for quantifying physical activity, offering valuable information on sarcopenia, and serving as a clinical diagnostic tool for this disorder characterized by reduced muscle mass and function. Multiple studies utilizing accelerometers have uncovered connections between levels of physical activity and sarcopenia.[9] Prior studies have established a clear correlation between physical activity intensity measured by accelerometers and both muscle mass and metabolic equivalent in the elderly population.[10] This narrative review aims to provide information on the Actigraph wGT3X-BT accelerometer as a clinical diagnostic of sarcopenia.



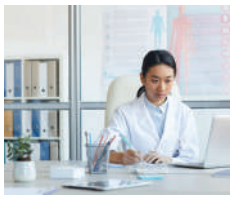
Scheme. PRISMA flowchart study.

Method

The assignment involves a thorough review of relevant literature on the correlation between sarcopenia and the Actigraph wGT3XBT accelerometer measurement. Data was collected from secondary data obtained from various search engines, including Google Scholar, Multidisciplinary Digital Publishing Institute (MDPI), PubMed, Wiley Online Library, and Elsevier, using three keywords "actigraph wGT3XBT" or "accelerometer" and "diagnostic" not "prognostic" and "sarcopenia". The inclusion criteria were full articles in English. The exclusion criteria included inaccessible papers and studies in a narrative format. The process of data searching following the PRISMA flow chart is illustrated in **Scheme**.

Discussion

The mechanism of sarcopenia is related to the imbalance between muscle cell production and degradation. As we age, muscle cells will gradually decrease, leading to decreased mitochondrial function, genetic mutations, decreased insulin sensitivity, and neuromuscular disorders. There is a correlation with reduced production of hormones such as growth hormone (GH), insulin-like growth factor - 1 (IGF-1), testosterone, and estradiol. Alterations in IGF-1 signaling and diminished insulin sensitivity can impact myogenesis.[4] The current benchmark for diagnosing sarcopenia is based on the 2018 criteria established by the European Working Group on Sarcopenia in Older People (EWGSOP).[9] These criteria consist of four stages: identifying cases, evaluating cases, confirming cases, and assessing the severity of the condition. The initial stage commences with a two-phase algorithm as outlined by Cruz-Jentoft, followed by a questionnaire, utilization of walkers, ability to rise from a chair, ascend stairs, and assessment of fall frequency. In the second phase, muscle strength was evaluated by quantifying grip strength with a calibrated handheld dynamometer. The third phase involves dual energy x-ray absorptiometry (DEXA) examination to measure the overall skeletal muscle mass of the body. This examination can also be done using bioelectrical impedance

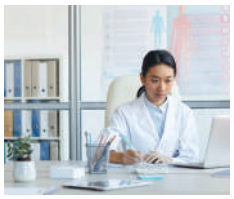


analysis (BIA) or computed tomography (CT) examination, as well as magnetic resonance imaging (MRI). In the fourth phase, once sarcopenia is diagnosed based on reduced muscle mass, the severity is assessed by physical performance. The assessments include walking rate, the short physical performance battery (SPPB), and the timed-up and go test (TUG).[2,3] Sarcopenia diagnosis criteria according to AWGS include low muscle strength, defined as a grip strength of less than 28 kg for males and less than 18 kg for females. Low physical performance is determined by a walking ability of less than 1.0 m/s over a 6-meter distance, a short physical performance result of 9 or less, or a standing test on a chair for at least 12 seconds while performing 5 repetitions. The evaluation of appendicular skeletal muscle mass (ASM) involved the use of dual energy x-ray absorptiometry (DEXA) with a threshold of < 7.0 kg/m^2 for males and <5.4 kg/m^2 for females. Bioelectrical impedance analysis (BIA) was also employed, with a threshold of <7.0 kg/m^2 for males and <5.7 kg/m^2 for females.[11]

Diagnosis of sarcopenia and its consequences necessitates the integration of a diagnostic system utilizing the Actigraph wGT3X-BT accelerometer (**Figure**). An accelerometer is a

Table 1. PICO analysis.

Study	Type of Study	Keywords	Search Terms	Search Strategies	Population	Intervention	Comparison	Outcome
Gao, *et al.*, 2021.[12]	Comprehen-sive Survey	Physical activity in elderly people	Physical performance	Physical performance	Geriatric patients	Accelerometer	Conventional diagnosis (EWGSOP and AWGS)	Accelerometer becomes a tool for early diagnosis of sarcopenia
Rowe, *et al.*, 2019.[13]	Comprehensive Review	Motion sensors	Motion sensors	Motion	Geriatric patients	Accelerometer	Wrist and hip accelerometer applications	Accelerometer potential at the wrist is better than the pelvis
Thornton, *et al.*, 2023.[14]	Research Article	Possible sarcopenia	Sarcopenia	Sarcopenia	Geriatric patients	Use of Acti Graph(GT3X) accelerometer to diagnose early sarcopenia	Physical activity measurement methods and accelerometer use with possible sarcopenia	ActiGraph accelerometer (GT3X) has high predictability in diagnosing early sarcopenia
Veen, *et al.*, 2021.[15]	Cross-Sectional Study	Resistance exercise	Muscle mass	Muscle	Geriatric patients	Accelerometer	Diagnosis according to Muscle Strengthening Activities (MSA)	Higher diagnostic accuracy than MSA
Airlie, *et al.*, 2022.[16]	Original Research	Accelerometer	ActiGraph wGT3X+	ActiGraph wGT3X+	Older adults	ActiGraph wGT3X+ accelerometer used in the pelvis	Conventional (physical activity)	ActiGraph wGT3X+ accelerometer can estimate physical activity and sedentary behavior
Aadland & Ylvisake, *et al.*, 2015.[17]	Research Article	Accelerometer in adult	Accelerome-ter	Accelerome-ter	Older adults	Actigraph GT3X+ accelerometer used in the pelvis	Use of accelerometer in contralateral pelvis	The Actigraph GT3X+ accelerometer is a reliable tool for measuring Physical Activity in free- living older adults using normal data reduction criteria.



sensor that detects changes in an individual's gravitational acceleration and offers specific information about their movement, such as direction and duration.[12] Accelerometers possess the capability to quantify physical activity and sedentary behavior, providing vital insight into sarcopenia. Several studies utilizing accelerometers have uncovered possible connections between levels of physical activity and sarcopenia. In general, accelerometers enable activity patterns measurement relevant to sarcopenia. While there is still a need for more clarification on diagnostic consensus and dose-response correlations, accelerometers have demonstrated their usefulness in epidemiologic research on sarcopenia. Ensuring the standardization of accelerometer methodology and purpose is crucial for the development of effective interventions for sarcopenia.[9]

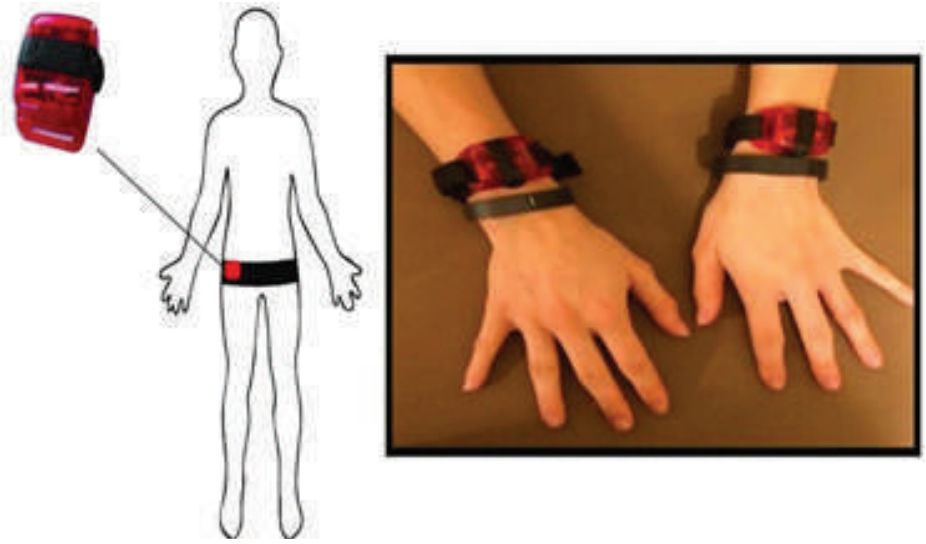


Figure. Accelerometer use in both the waist and wrist.[13,14]

Table 2. GT3X indicators based on physical activity for early diagnosis of sarcopenia.[10]

Characteristics	Total (n=146, 100%)	Possible Sarcopenia		
		Yes (n=19, 13%)	No (n=127, 87%)	p-value
GT3X indicators				
SED, min/wk	4628.1 ± 734.8	4656.7 ± 755.7	4623.8 ± 734.6	0.856
LPA, min/wk	1195.5 ± 566.6	987.8 ± 434.2	1226.6 ± 578.8	0.087
MVPA, min/wk	1061.8 ± 869.3	774.9 ± 1036.4	1104.8 ± 837.7	0.123
PAEE, kcal	1908.5 ± 1218.7	1101.7 ± 657.7	2029.2 ± 1238.7	<0.001*
Step counts, steps/wk	53855.7 ± 30206.0	49003.3 ± 33332.8	54581.7 ± 29785.5	0.455
MET	7.9 ± 0.8	7.4 ± 0.4	8.0 ± 0.8	<0.001*

Abbreviations: SED: Sitting activity time; LPA: Light physical activity; MVPA: Moderate and vigorous physical activity; PAEE: Physical activity energy expenditure; MET: Metabolic equivalent. * : Significant result

Table 3. Diagnostic criteria according to EWGS using accelerometer in diagnosing sarcopenia in men compared to women.[15]

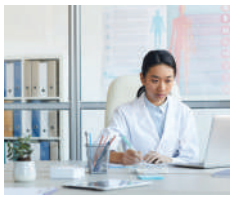
	Male	Female
n	71	122
Age, y	67 ± 2	67 ± 2
Sarcopenia Risk Components		
SMI, % BW	34.5 ± 3.2	26.8 ± 3.4 *
Handgrip, kg	44.1 ± 7.0	28.2 ± 5.2
5STS	10.0 ± 2.0	10.2 ± 2.3

Abbreviations: BW: Body weight; kg: Kilogram; SMI: Skeletal muscle index; 5STS: 5-time sit-to-stand; HG: Handgrip. *p<0.05.[15]

Today, accelerometers have become widely accepted as the essential device-based tool for assessing physical activity and sedentary behavior due to their precision, cost-effectiveness, and user-friendly nature.[18] Recently, there has been a shift from placing accelerometer monitors on the hip to placing them on the wrist. Nevertheless, the many methodologies and data analysis approaches being developed for hip-worn accelerometers are not applicable to wrist-worn accelerometers.

The ActiGraph accelerometers, specifically the GT3X+ and Link GT9X models, are widely recognized as the leading movement sensors used in physical activity research. These devices provide highly detailed information about an individual's physical activity intensity (ranging from sedentary to vigorous), duration spent at different activity levels, estimated energy expenditure, pace, and raw data. Accelerometers have been proven to be valid and reliable, and are widely acknowledged as an accurate and objective tool for measuring physical activity in both observational and intervention studies conducted globally.[12]

Actigraph wGT3X-BT accelerometers were used to measure physical activity. Each accelerometer unit was utilized on both hips. This procedure enables precise analysis of the disparity between the hips, hence avoiding any confusion between the disparity of the hips and the disparity of accelerometer units. Participants were directed to consistently wear the accelerometer, except during water-based activities such as swimming and bathing, as well as during sleep. The accelerometers were initialized at a sampling frequency of 30 Hz. The files were analyzed at a duration of 10 seconds using the Kinesoft v.3.3.75 program.[18] The unprocessed accelerometer data were downloaded and subjected to filtering using the typical filter option. The filtered data was then integrated using ActiLife software. The



daily duration of wearing was determined by subtracting the non-wearing time from the total available minutes in a day.[18]

The PICO analysis was conducted to systematically formulate the focus of the study. This approach helps identify the relevant population, the intervention being examined, the comparison applied, and the expected outcomes. The results of the PICO analysis are presented concisely to facilitate understanding and interpretation. The PICO table analysis was shown in **Table 1**, which clearly illustrates the key elements forming the foundation of this study.

Zhu Cheng, *et al*.,[18] conducted a study on 146 elderly individuals, with an average age of 72.6 ± 5.6 years; 105 (72%) were women and 41 (28%) were men. **Table 2** displays GT3X signs for the initial diagnosis of sarcopenia based on AWGS criteria. The importance of physical activity in relation to potential sarcopenia lies in the concepts of Physical Activity Energy Expenditure (PAEE) and Metabolic Equivalent (MET).[18]

Veen Jort, *et al*., study[15] included a sample size of 193 elderly individuals, both male and female, with ages ranging from 65 to 70 years. The characteristics of the participants are presented in **Table 3**.[14] Males exhibited considerably greater hand grip strength ($p<0.05$) and skeletal muscle index ($p<0.05$) compared to females, although there was no difference in the 5-second sit-to-stand test. This can be attributed to the greater magnitude of physical exertion exhibited by men in comparison to women.[16]

Conclusion

The utilization of the Actigraph wGT3X-BT accelerometer in diagnostic procedures presents the possibility to promptly identifying sarcopenia in the elderly population. This technique has been demonstrated to be superior in identifying sarcopenia in elderly individuals when compared to the AWGS/EWGS criteria only. The system may provide comprehensive data regarding an individual's level of physical activity, including their sedentary, light, moderate, and strenuous activity levels, the duration of each activity intensity, estimated energy expenditure, and pace. However, data on the use of Actigraph wGT3X-BT in Indonesia is still scarce. Further research is necessary to assess its diagnostic capabilities.

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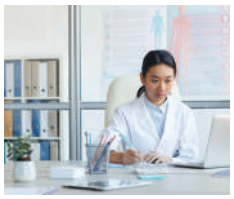

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