CORRELATION BETWEEN MUSCLE STRENGTH, CALF CIRCUMFERENCE, VITAMIN D, AND IGF-1 ON DEPRESSION IN THE ELDERLY

Paskalis Andrew Gunawan[1*], Anastasia Ratnawati Biromo[2], Alexander Halim Santoso[3], Bryan Anna Wijaya[4], Kasvana[5], Louise Audrey Sukianto[6], Yohanes Firmansyah[7]

[1-7]Faculty of Medicine, Universitas Tarumanagara

Correspondence E-mail: paskalisg@fk.untar.ac.id

Disubmit: 02 September 2025 Diterima: 10 April 2026 Diterbitkan: 01 Mei 2026
Doi: https://doi.org/10.33024/mahesa.v6i5.22435

ABSTRACT

Depression in the elderly is a multifaceted issue influenced by various physiological factors. This study investigates the correlation between muscle strength, calf circumference, Vitamin D, and Insulin-like Growth Factor 1 (IGF-1) levels and their collective impact on depression among the elderly. This study aims to understand the correlation between muscle strength, calf circumference, Vitamin D, and IGF-1 levels on depression to develop targeted interventions to improve mental health outcomes in this demographic. This cross-sectional study involved 82 older people at RPTRA Krendang. Depression is measured using the Geriatric Depression Scale (GDS). Data were analyzed using Spearman's Rho to see the Correlation between Muscle Strength, Calf Circumference, Vitamin D, and IGF-1 on Depression in the Elderly. The study found most respondents were female (78%), with an average age of 74.34 years, and according to the Geriatric Depression Scale, the majority (59.8%) of respondents were normal. This study highlighted significant correlations between muscle strength, calf circumference, and decreased Vitamin D and IGF-1 levels with higher depression scores. These findings suggest that diminished physical health markers and nutrient deficiencies are associated with increased depressive symptoms in the elderly. Measuring muscle strength, calf circumference, Vitamin D, and IGF-1 levels is a good approach to understanding depression in the elderly that will lead to effective interventions by health workers and improve quality of life.

Keywords: Calf Circumference; Depression; IGF-1; Muscle Strength; Vitamin D.

INTRODUCTION

Depression is the most prevalent and severe mental disorder worldwide among the elderly, seriously affecting their quality of life. As a global public health problem, it dramatically burdens international health care. (Khanal et al., 2024; Liu et al., 2024) The global prevalence rate of depression among the elderly ranges from 3% to 30%. Depression among the elderly may lead them to suicide. (Giri et al., 2016; Idaiani & Indrawati, 2021; Obuobi-Donkor et al., 2021) About 20% of the population will suffer from depression at some point in their lives. (Malhi & Mann, 2018; Sepehrmanesh et al., 2016) Symptoms of depression include persistent sadness, emptiness, and hopelessness. Patients may lose

interest in previously engaging activities (anhedonia), changes in appetite, and sleep disturbances. Other manifestations include psychomotor retardation or agitation, chronic fatigue or loss of energy, pervasive feeling of being trapped, inability to concentrate, suicidal ideation, or self-harm behaviour. The high prevalence of depression in older adults is a serious concern because untreated depression can dramatically reduce the quality of life and contribute to increased morbidity and mortality. (Maier et al., 2021; Susy Olivia et al., 2024)

Depression in the elderly is a multifactorial condition with an etiology involving a complex interplay between genetic, environmental, and psychological factors. Among the various factors, physical health markers such as muscle strength and calf circumference are associated with depression in the elderly. (Ganipineni et al., 2023; Smith et al., 2018; Tan et al., 2022) Age-related loss of muscle mass and strength (sarcopenia) occurs naturally and can eventually lead to frailty, increased risk of falls and injuries, and loss of independence. The psychological impact of the loss of physical capabilities can lead to a sense of powerlessness and social isolation, both of which are known to be risk factors for depression. (Champaiboon et al., 2023; Ganipineni et al., 2023; Larsson et al., 2019; Tan et al., 2022)

Besides their role in the body's physiological health, Vitamin D and IGF-1 are pivotal in maintaining mental health, particularly in older adults. Vitamin D is known to play a role in mood and cognition. Vitamin D deficiency is common in older adults and has been associated with an increased risk of depressive disorders. Its role in neurotransmitter synthesis, neuroplasticity, and other central nervous system processes highlights its importance in mood stabilization. Similarly, IGF-1, a hormone involved in growth and development, is increasingly recognized for contributing to brain health and cognitive function. Abnormal IGF-1 levels may also be reflective of underlying metabolic or endocrine disorders, which in turn may contribute to mood disorders in the elderly. (Ceolin et al., 2023; Chigogora et al., 2016; Okereke & Singh, 2016)

Understanding the interplay between muscle strength, calf circumference, Vitamin D, and IGF-1 is essential, as these factors offer critical insights into the health and functional capacity of the elderly population. The purpose of this study is to explore the correlation of these physical and biochemical parameters with depression in the elderly. Through this exploration, this study hopes to provide an understanding and further contribution to the early recognition of depression and its related health problems that will lead to effective interventions by health workers and improve the quality of life.

LITERATURE REVIEW

Depression represents a complex mood disorder characterized by pervasive sadness, anhedonia, and disturbances in sleep and appetite regulation. Its clinical manifestations extend beyond affective symptoms, considerably impacting cognitive performance, physical health, and overall quality of life. Among older adults, the burden of depression is particularly pronounced, with multiple biological and physiological determinants implicated in its pathogenesis. Notably, sarcopenia, vitamin D

insufficiency, and diminished levels of anabolic mediators such as insulin-like growth factor-1 (IGF-1) have emerged as critical risk factors, underscoring the interplay between musculoskeletal decline, endocrine dysregulation, and late-life mood disorders. (Bąk et al., 2022; Güney et al., 2008; Idaiani & Indrawati, 2021)

Sarcopenia, defined as the age-associated loss of skeletal muscle mass and strength, constitutes one of the most prominent contributors to depression in later life. Reduced muscle function frequently limits physical activity, which in turn fosters social withdrawal and isolation, both well-established drivers of depressive symptomatology. Beyond functional decline, the systemic inflammation that often accompanies sarcopenia exerts profound neurobiological effects, particularly on neurotransmitter systems such as serotonin and dopamine that regulate mood. Elevated circulating levels of pro-inflammatory cytokines, including interleukin-6 (IL-6) and tumor necrosis factor-alpha (TNF-α), have been consistently associated with disturbances in affective regulation, thereby linking sarcopenia-induced inflammation with an increased vulnerability to depression. (Kim et al., 2010; Tsaras et al., 2021; Yu et al., 2022)

Vitamin D also plays a pivotal role in both mental health and musculoskeletal integrity, and its deficiency, which is highly prevalent among older populations, has been consistently associated with an elevated risk of depression. The underlying mechanisms are multifactorial and involve widespread vitamin D receptors (VDRs) distributed in skeletal muscle and critical brain regions, particularly the hippocampus, which is central to mood regulation. Insufficient vitamin D availability may impair neurotransmitter pathways, most notably serotonin synthesis and signaling, thereby predisposing individuals to affective disturbances. Furthermore, vitamin D exerts potent anti-inflammatory effects; inadequate levels are linked to heightened systemic inflammation through increased expression of pro-inflammatory cytokines such as interleukin-6 (IL-6), which have been implicated in the pathophysiology of depression. Significantly, vitamin D deficiency may exacerbate sarcopenia, creating a synergistic cycle of muscle weakness, inflammation, and neurochemical dysregulation that further amplifies susceptibility to late-life depression. (Cordeiro et al., 2020; Yap et al., 2017; Zhang & Tian, 2022)

Insulin-like growth factor-1 (IGF-1) is another critical determinant of both musculoskeletal and neurocognitive health. As a peptide hormone involved in muscle growth, regeneration, and neuronal function, IGF-1 is fundamental in maintaining resilience against age-related decline. Reduced circulating IGF-1 levels, a common feature of aging, have been consistently associated with heightened vulnerability to depression. Mechanistically, IGF-1 supports neuroplasticity—the brain's capacity to adapt, remodel, and repair neuronal circuits—which is essential for emotional regulation and stress resilience. Insufficient IGF-1 impairs the integrity of limbic neural pathways, disrupting mood regulation, while also diminishing its neuroprotective and anti-inflammatory functions within the central nervous system. This dual impact—loss of synaptic adaptability and increased neuroinflammation—

represents a convergent mechanism linking IGF-1 deficiency to late-life depression. Notably, the co-occurrence of low IGF-1 levels and sarcopenia may exert synergistic effects, further amplifying depressive risk in older adults. (Jin et al., 2022; Monk et al., 2013; Yu et al., 2022).

RESEARCH METHODS

This study was conducted in 2024 with a cross-sectional design that involved 82 older people at Kelurahan Krendang, recruited using purposive sampling. Those eligible for inclusion were people aged 60 or older with the cognitive capability to understand the study requirements and to give consent to participate, including blood taking. Respondents were excluded if they had severe cognitive impairment (e.g., dementia), which made them unable to understand or participate in the study. People taking medication known to have the potential to impact muscle strength or mood (e.g., high-dose corticosteroids, antidepressants, or mood stabilizers) were excluded, as well as those taking high-dose Vitamin D supplements.

This study includes measurement of muscle strength, calf circumference, vitamin D, and IGF-1. Muscle strength was measured with Omron Handgrip Strength in kilograms (kg). Calf circumference was measured with tape and recorded in centimetres (cm). Vitamin D and IGF-1 levels were measured with the ELISA method, presented in nanograms per millilitre (ng/mL). The depression variable was measured with the Geriatric Depression Scale (GDS). The GDS is a tool used to find depressive symptoms in the elderly and questions about mood, activity, and daily activities employing 15 'Yes' or 'No' questions. GDS score is divided into 4 categories: normal (0-4), mild (5-8), moderate (9-11), and severe (12-15) depression. All devices were calibrated before use to ensure accuracy. Standard protocol was also used to provide the reliability and validity of the measurements and results obtained.

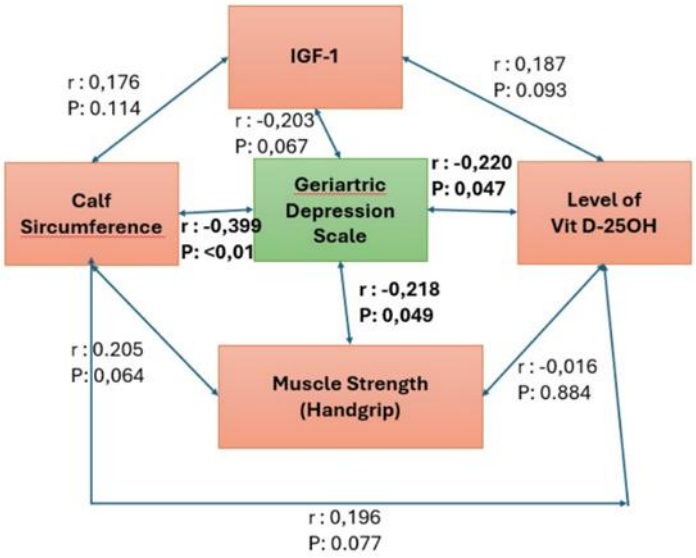
In this study, data analysis using SPSS v.26 was carried out to process univariate and bivariate data quantitatively. The normality of the data was tested using the Kolmogorov-Smirnov test. Spearman's Rho test was used to determine the relationship between muscle strength, calf circumference, vitamin D, IGF-1, and depression in the elderly. The Spearmen's Rho test is a test to determine the non-parametric correlation test with a significant value of $p < 0.05$. The size of the correlation is negligible (0.00-0.10), weak (0.10-0.39), moderate (0.40-0.69), strong (0.70-0.89), and very strong (0.90-1.00). The characteristics of the respondents were presented in the form of means and standard deviations.

RESEARCH RESULTS

Table 1. Respondent Characteristics

Parameter	Results
Gender	
• Male	18 (22%)
• Female	64 (78%)
Age (SD) (years)	74.34 (9.26)
Handgrip strength (SD) (kg)	10.57 (6.5)
Vitamin D (25(OH)D) (SD) (ng/mL)	9.75 (4.7)
Insulin-like Growth Factor (IGF) (SD) (ng/mL)	14.43 (14.25)
Calf Circumference (SD) (cm)	18.58 (4.61)
Geriatric Depression Scale (SD)	4.46 (4.35)
• Normal	49 (59.8%)
• Mild	16 (19.5%)
• Moderate	8 (9.8%)
• Severe	9 (11%)

The study included 82 respondents, and their characteristics are shown in Table 1. Most respondents were female (78%), with an average age of 74.34 years. Handgrip strength averaged 10.57 kg, and Vitamin D 25(OH) and Insulin-like Growth Factor (IGF) levels were 9.75 and 14.43, respectively. The average calf circumference was 18.58 cm. According to the Geriatric Depression Scale, the majority (59.8%) of respondents were normal, while 19.5% had mild depression, 9.8% had moderate depression, and 11% had severe depression.



*Note: Handgrip uses the dominant hand (right)

Figure 1. Correlation between Muscle Strength, Calf Circumference, Vitamin D, and IGF-1 on Depression in the Elderly Population

Normality testing of data distribution was conducted using the Kolmogorov-Smirnov test, which is suitable for samples over 50. The results showed that all variable's results were distributed abnormally. Further, the results showed significant correlations between many factors and GDS, with particular emphasis on the impact of muscle-related factors on depression in the elderly. Calf circumference was shown to correlate negatively with depression ($r = -0.399$, $p < 0.01$), with the amount of muscle on the legs contributing to the score on the depression scale. The muscle strength expressed by hand grip also correlated negatively with depression ($r = -0.218$, $p= 0.049$), indicating that muscle strength served to prevent depression. While IGF-1 affects muscle growth, its effect on muscle structure, as indicated by calf circumference, was not confirmed. Still, a weak negative correlation with depression was seen ($r = -0.203$, $p= 0.067$), providing evidence for an indirect contribution. The level of vitamin 25(OH)D3 also correlated negatively with depression ($r = -0.220$, $p= 0.047$), indicating an indirect contribution to depression severity. These results indicated the importance of these physical and biochemical factors in depression in the elderly.

DISCUSSION

Sarcopenia, defined as low muscle mass and strength, is common in the elderly. Low muscle strength is associated with more depressive symptoms, possibly due to systemic inflammation, as low muscle strength is also associated with higher levels of pro-inflammatory cytokines. These cytokines tend to increase with less handgrip strength. The pro-inflammatory cytokines inhibit the synthesis of serotonin, glutamate, and dopamine neurotransmitters, which are responsible for mood regulation, especially joy. (Danese & J Lewis, 2017; Marques et al., 2020; Remes et al., 2021) At the same time, skeletal muscles are supposed to secrete myokines that affect the brain to improve mood and cognition and protect cells from neuronal damage, suggesting a muscle-brain interaction. People with sarcopenia are 49% more likely to develop new depressive symptoms compared to those without sarcopenia. (Gao et al., 2021)

On the other hand, Vitamin D is implicated in the pathophysiology of depression. (Santoso et al., 2024) As an anti-inflammatory agent, vitamin D mitigates the expression of inflammatory cytokines, and its deficiency may result in an elevation of cytokines that can be incriminated in depression. (Bakhtiari-Dovvombaygi et al., 2021; Holick et al., 2023) In addition, Vitamin D can also affect serotonin production by regulating the expression of tryptophan hydroxylase and the expression of antioxidant genes, including nuclear factor-erythroid-2-related factor 2 (NRF2), γ-glutamyl transpeptidase (γ-GT), glutathione reductase (GR), glutathione peroxidase (GPx), which can protect neurons from oxidative damage. Consequently, a deficiency in Vitamin D (25-OH-D3) can elevate the risk of depression. (Grozić et al., 2022; Kim et al., 2020; Sabir et al., 2020)

IGF-1 may play a role in the symptoms of depression by modulating inflammatory processes.

It inhibits inflammatory markers, including IFN-γ, IL-1ß, TNF-α, iNOS, and GFAP, and pro-inflammatory agents, such as IL-4, IL-10, and BDNF. IGF-1 can also affect various cerebral processes, including synaptic plasticity, adult neurogenesis, neuronal differentiation, etc. The disruption of the IGF-1 gene can lead to neuronal loss in the hippocampus, striatum, and dentate gyrus in rats. It can cause an age-dependent decrease in the differentiation of newborn cells into neurons. (Levada & Troyan, 2017; Qiao et al., 2024)

These findings collectively underscore the complex interplay between muscle health, Vitamin D, and IGF-1 levels in influencing depression among the elderly population. However, several limitations should be considered when interpreting the results. The cross-sectional nature of this study does not allow for a causal relationship to be established and only shows an association at a single point in time. Furthermore, the older adults assessed were Krendang, Jakarta residents, and may not be generalized to other older adult populations or settings. Finally, potential confounding variables such as nutritional status.

CONCLUSION

Measuring muscle strength, calf circumference, Vitamin D, and IGF-1 levels is a good approach to understanding depression in the elderly because it emphasizes the relationship between physical health markers and mental health. Interventions to improve muscle strength and optimize Vitamin D and IGF-1 levels may play a key role in ameliorating depressive symptoms in older adults. Future studies are recommended to use intervention studies to evaluate the effects of physical exercises, nutritional supplements, or treatments to modify these factors and their impact on depression.

BIBLIOGRAPHY

Bąk, E., Młynarska, A., Marcisz, C., Kadłubowska, M., Marcisz-Dyla, E., Sternal, D., Młynarski, R., & Krzemińska, S. (2022). Kinesiophobia In Elderly Polish Patients After Ischemic Stroke, Including Frailty Syndrome. Neuropsychiatric Disease And Treatment. Https://Doi.Org/10.2147/Ndt.S352151

Bakhtiari-Dovvombaygi, H., Izadi, S., Zare Moghaddam, M., Hashemzehi, M., Hosseini, M., Azhdari-Zarmehri, H., Dinpanah, H., & Beheshti, F. (2021). Beneficial Effects Of Vitamin D On Anxiety And Depression-Like Behaviors Induced By Unpredictable Chronic Mild Stress By Suppression Of Brain Oxidative Stress And Neuroinflammation In Rats. Naunyn-Schmiedeberg's Archives Of Pharmacology, 394(4), 655–667. Https://Doi.Org/10.1007/S00210-020-02002-0

Ceolin, G., Antunes, L. Da C., Moretti, M., Rieger, D. K., & Moreira, J. D. (2023). Vitamin D And Depression In Older Adults: Lessons Learned From Observational And Clinical Studies. Nutrition Research Reviews, 36(2), 259–280. Https://Doi.Org/10.1017/S0954422422000026

Champaiboon, J., Petchlorlian, A., Manasvanich, B., Ubonsutvanich, N., Jitpugdee, W., Kittiskulnam, P.,

Wongwatthananart, S., Menorngwa, Y., Pornsalnuwat, S., & Praditpornsilpa, K. (2023). Calf Circumference As A Screening Tool For Low Skeletal Muscle Mass: Cut-Off Values In Independent Thai Older Adults. Bmc Geriatrics, 23(1), 826. Https://Doi.Org/10.1186/S12877-023-04543-4

Chigogora, S., Zaninotto, P., Kivimaki, M., Steptoe, A., & Batty, G. D. (2016). Insulin-Like Growth Factor 1 And Risk Of Depression In Older People: The English Longitudinal Study Of Ageing. Translational Psychiatry, 6(9), E898–E898. Https://Doi.Org/10.1038/Tp.2016.167

Cordeiro, R. C., Santos, R. C. Dos, Araújo, G. K. N. De, Nascimento, N. De M., Souto, R. Q., Ceballos, A. G. Da C. De, Alves, F. A. P., & Santos, J. (2020). Mental Health Profile Of The Elderly Community: A Cross-Sectional Study. Revista Brasileira De Enfermagem. Https://Doi.Org/10.1590/0034-7167-2018-0191

Danese, A., & J Lewis, S. (2017). Psychoneuroimmunology Of Early-Life Stress: The Hidden Wounds Of Childhood Trauma? Neuropsychopharmacology, 42(1), 99–114. Https://Doi.Org/10.1038/Npp.2016.198

Ganipineni, V. D. P., Idavalapati, A. S. K. K., Tamalapakula, S. S., Moparthi, V., Potru, M., & Owolabi, O. J. (2023). Depression And Hand-Grip: Unraveling The Association. Cureus. Https://Doi.Org/10.7759/Cureus.38632

Gao, K., Ma, W.-Z., Huck, S., Li, B.-L., Zhang, L., Zhu, J., Li, T., & Zhou, D. (2021). Association Between Sarcopenia And Depressive Symptoms In Chinese Older Adults: Evidence From The China Health And Retirement Longitudinal Study. Frontiers In Medicine, 8. Https://Doi.Org/10.3389/Fmed.2021.755705

Giri, M., Chen, T., Yu, W., & Lü, Y. (2016). Prevalence And Correlates Of Cognitive Impairment And Depression Among Elderly People In The World&Rsquo;S Fastest Growing City, Chongqing, People&Rsquo;S Republic Of China. Clinical Interventions In Aging, Volume 11, 1091–1098. Https://Doi.Org/10.2147/Cia.S113668

Grozić, A., Coker, K., Dussik, C. M., Sabir, M. S., Sabir, Z., Bradley, A., Zhang, L., Park, J., Yale, S., Kaneko, I., Hockley, M., Harris, L. A., Lunsford, T. N., Sandrin, T. R., & Jurutka, P. W. (2022). Identification Of Putative Transcriptomic Biomarkers In Irritable Bowel Syndrome (Ibs): Differential Gene Expression And Regulation Of Tph1 And Sert By Vitamin D. Plos One, 17(10), E0275683. Https://Doi.Org/10.1371/Journal.Pone.0275683

Güney, İ., Biyik, M., Yeksan, M., Biyik, Z., Atalay, H., Solak, Y., Selçuk, N. Y., Tonbul, H. Z., & Türk, S. (2008). Sleep Quality And Depression In Peritoneal Dialysis Patients. Renal Failure. Https://Doi.Org/10.1080/08860220802406419

Holick, M. F., Mazzei, L., García Menéndez, S., Martín Giménez, V. M., Al Anouti, F., & Manucha, W. (2023). Genomic Or Non-Genomic? A Question About The Pleiotropic Roles Of Vitamin D In

Inflammatory-Based Diseases. Nutrients, 15(3), 767. Https://Doi.Org/10.3390/Nu15030767

Idaiani, S., & Indrawati, L. (2021). Functional Status In Relation To Depression Among Elderly Individuals In Indonesia: A Cross-Sectional Analysis Of The Indonesian National Health Survey 2018 Among Elderly Individuals. Bmc Public Health, 21(1), 2332. Https://Doi.Org/10.1186/S12889-021-12260-Z

Jin, B., Zhang, H., Song, F., Wu, G., & Ye, H. (2022). Interaction Of Sleep Duration And Depression On Cardiovascular Disease: A Retrospective Cohort Study. Bmc Public Health. Https://Doi.Org/10.1186/S12889-022-14143-3

Khanal, G., Selvamani, Y., Thapa, S., & Chinnaiyan, S. (2024). Prevalence And Covariates Of Depression Among Older Adults In Nepal: A Systematic Review And Meta-Analysis. Plos Mental Health, 1(4), E0000112. Https://Doi.Org/10.1371/Journal.Pmen.0000112

Kim, H. A., Perrelli, A., Ragni, A., Retta, F., De Silva, T. M., Sobey, C. G., & Retta, S. F. (2020). Vitamin D Deficiency And The Risk Of Cerebrovascular Disease. Antioxidants, 9(4), 327. Https://Doi.Org/10.3390/Antiox9040327

Kim, K. W., Yoon, I.-Y., Chung, S., Shin, Y., Lee, S. B., Choi, E. A., Park, J. H., & Kim, J. M. (2010). Prevalence, Comorbidities And Risk Factors Of Restless Legs Syndrome In The Korean Elderly Population – Results From The Korean Longitudinal Study On Health And Aging. Journal Of Sleep Research. Https://Doi.Org/10.1111/J.1365-2869.2009.00739.X

Larsson, L., Degens, H., Li, M., Salviati, L., Lee, Y. Il, Thompson, W., Kirkland, J. L., & Sandri, M. (2019). Sarcopenia: Aging-Related Loss Of Muscle Mass And Function. Physiological Reviews, 99(1), 427–511. Https://Doi.Org/10.1152/Physrev.00061.2017

Levada, O. A., & Troyan, A. S. (2017). Insulin-Like Growth Factor-1: A Possible Marker For Emotional And Cognitive Disturbances, And Treatment Effectiveness In Major Depressive Disorder. Annals Of General Psychiatry, 16(1), 38. Https://Doi.Org/10.1186/S12991-017-0161-3

Liu, J., Liu, Y., Ma, W., Tong, Y., & Zheng, J. (2024). Temporal And Spatial Trend Analysis Of All-Cause Depression Burden Based On Global Burden Of Disease (Gbd) 2019 Study. Scientific Reports, 14(1), 12346. Https://Doi.Org/10.1038/S41598-024-62381-9

Maier, A., Riedel-Heller, S. G., Pabst, A., & Luppa, M. (2021). Risk Factors And Protective Factors Of Depression In Older People 65+. A Systematic Review. Plos One, 16(5), E0251326. Https://Doi.Org/10.1371/Journal.Pone.0251326

Malhi, G. S., & Mann, J. J. (2018). Depression. The Lancet, 392(10161), 2299–2312. Https://Doi.Org/10.1016/S0140-6736(18)31948-2

Marques, A., Gomez-Baya, D., Peralta, M., Frasquilho, D., Santos, T., Martins, J., Ferrari, G., & Gaspar De Matos, M. (2020). The Effect Of Muscular Strength On Depression

Symptoms In Adults: A Systematic Review And Meta-Analysis. International Journal Of Environmental Research And Public Health, 17(16), 5674. Https://Doi.Org/10.3390/Ijerph17165674

Monk, T. H., Pfoff, M. K., & Zarotney, J. R. (2013). Depression In The Spousally Bereaved Elderly: Correlations With Subjective Sleep Measures. Depression Research And Treatment. Https://Doi.Org/10.1155/2013/409538

Obuobi-Donkor, G., Nkire, N., & Agyapong, V. I. O. (2021). Prevalence Of Major Depressive Disorder And Correlates Of Thoughts Of Death, Suicidal Behaviour, And Death By Suicide In The Geriatric Population—A General Review Of Literature. Behavioral Sciences, 11(11), 142. Https://Doi.Org/10.3390/Bs11110142

Okereke, O. I., & Singh, A. (2016). The Role Of Vitamin D In The Prevention Of Late-Life Depression. Journal Of Affective Disorders, 198, 1–14. Https://Doi.Org/10.1016/J.Jad.2016.03.022

Qiao, X., Yan, J., Zang, Z., Xi, L., Zhu, W., Zhang, E., & Wu, L. (2024). Association Between Igf-1 Levels And Mdd: A Case-Control And Meta-Analysis. Frontiers In Psychiatry, 15. Https://Doi.Org/10.3389/Fpsyt.2024.1396938

Remes, O., Mendes, J. F., & Templeton, P. (2021). Biological, Psychological, And Social Determinants Of Depression: A Review Of Recent Literature. Brain Sciences, 11(12), 1633. Https://Doi.Org/10.3390/Brainsci11121633

Sabir, Z. L., Livingston, S., Whitfield, G. K., Haussler, M. R., & Jurutka, P. (2020). Vitamin D Impacts Nrf-2 Signaling And Antioxidation Pathways That Modulate Cellular Aging. The Faseb Journal, 34(S1), 1–1. Https://Doi.Org/10.1096/Fasebj.2020.34.S1.09913

Santoso, A. H., Lontoh, S. O., Firmansyah, Y., Yogie, G. S., Goh, D., Syarifah, A. G., Teguh, S. K. M. M., & Khoto, A. E. P. (2024). Hubungan Kadar 25(Oh)D3 Dengan Lingkar Betis Pada Kelompok Lanjut Usia Di Panti Santa Anna: Studi Potong-Lintang. Malahayati Nursing Journal, 6(7), 2583–2591. Https://Doi.Org/10.33024/Mnj.V6i7.13124

Sepehrmanesh, Z., Kolahdooz, F., Abedi, F., Mazroii, N., Assarian, A., Asemi, Z., & Esmaillzadeh, A. (2016). Retracted: Vitamin D Supplementation Affects The Beck Depression Inventory, Insulin Resistance, And Biomarkers Of Oxidative Stress In Patients With Major Depressive Disorder: A Randomized, Controlled Clinical Trial. The Journal Of Nutrition, 146(2), 243–248. Https://Doi.Org/10.3945/Jn.115.218883

Smith, L., White, S., Stubbs, B., Hu, L., Veronese, N., Vancampfort, D., Hamer, M., Gardner, B., & Yang, L. (2018). Depressive Symptoms, Handgrip Strength, And Weight Status In Us Older Adults. Journal Of Affective Disorders, 238, 305–310. Https://Doi.Org/10.1016/J.Jad.2018.06.016

Susy Olivia, Alexander Halim Santoso, Alicia Herdiman, Yovian Timothy Satyo, Farell Christian Gunaidi, & Edwin Destra. (2024). Kegiatan Penapisan Kesehatan Mental Mengenai Depresi Pada Kelompok Lanjut Usia. Kreatif: Jurnal Pengabdian Masyarakat Nusantara, 4(2), 87–93. Https://Doi.Org/10.55606/Kreatif.V4i2.3380

Tan, J.-Y., Zeng, Q.-L., Ni, M., Zhang, Y.-X., & Qiu, T. (2022). Association Among Calf Circumference, Physical Performance, And Depression In The Elderly Chinese Population: A Cross-Sectional Study. Bmc Psychiatry, 22(1), 278. Https://Doi.Org/10.1186/S12888-022-03925-Z

Jin, B., Zhang, H., Song, F., Wu, G., & Ye, H. (2022). Interaction Of Sleep Duration And Depression On Cardiovascular Disease: A Retrospective Cohort Study. Bmc Public Health. Https://Doi.Org/10.1186/S12889-022-14143-3

Kim, K. W., Yoon, I.-Y., Chung, S., Shin, Y., Lee, S. B., Choi, E. A., Park, J. H., & Kim, J. M. (2010). Prevalence, Comorbidities And Risk Factors Of Restless Legs Syndrome In The Korean Elderly Population – Results From The Korean Longitudinal Study On Health And Aging. Journal Of Sleep Research. Https://Doi.Org/10.1111/J.1365-2869.2009.00739.X

Monk, T. H., Pfoff, M. K., & Zarotney, J. R. (2013). Depression In The Spousally Bereaved Elderly: Correlations With Subjective Sleep Measures. Depression Research And Treatment. Https://Doi.Org/10.1155/2013/409538

Tsaras, K., Tsiantoula, M., Papathanasiou, I. V, Papagiannis, D., Chatzi, M., & Fradelos, E. C. (2021). Predictors Of Depression And Insomnia In Community-Dwelling Elderly People: A Cross-Sectional Evidence Of Their Bidirectional Relationship. Cureus. Https://Doi.Org/10.7759/Cureus.13965

Yap, A. F., Kwan, Y. H., Tan, C. S., Ibrahim, S., & Ang, S. Bin. (2017). Rhythm-Centred Music Making In Community Living Elderly: A Randomized Pilot Study. Bmc Complementary And Alternative Medicine. Https://Doi.Org/10.1186/S12906-017-1825-X

Yu, A.-L., Lo, S., Chen, P.-Y., & Lu, S.-F. (2022). Effects Of Group Music Intervention On Depression For Elderly People In Nursing Homes. International Journal Of Environmental Research And Public Health. Https://Doi.Org/10.3390/Ijerph19159291

Zhang, Y., & Tian, Y. (2022). The Relationship Between Physical Activity And Depressive Symptoms In Middle-Aged And Elderly People Controlling For Demographic And Health Status Variables. Sustainability. Https://Doi.Org/10.3390/Su142113986