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Brain Gym Exercise Give Benefit to Improve Cognitive Function among Elderly: A Systematic Review

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ABSTRACT

Being elderly is potentially risk for the emerging of progressive neurodegenerative syndrome, including cognitive impairment. Various efforts have been made to minimize the negative impact. Brain gym is an alternative intervention that is widely used. A series of motion between the legs and hands employed to stimulate the brain to remain optimal. This study aims to determine whether brain gym exercise is beneficial for cognitive improvement among elderly in Indonesia. The systematic literature review was carried out from 28 May 2020 – 05 June 2020 at Semantic Scholar, Google Scholar, Garba Rujukan Digital (Garuda). Searching process employed keywords compiled using PICOS (Population, Intervention, Comparison and Outcomes) method and applied a filtering of articles using clinical trial or randomized controlled trial design, published in the last five years, and free/open access literature. There are 5 articles that meet the inclusion criteria: sample age 60 years and over, type of brain gym intervention, and focus on assessing cognitive function using the Mini-Mental State Examination (MMSE), Montreal Cognitive Assessment Indonesian Version (MoCA-Ina. Overall, the result shows in participants (n=211) experienced a significant increase in cognitive function (p<0.05). Indeed, additional outcomes were found, namely a decrease in stress levels and an increase in physical activity function.

Keywords: *brain gym; cognitive; elderly*

ABSTRAK

Usia lanjut menjadi faktor risiko munculnya sindrom neurodegeneratif progresif, termasuk gangguan kognitif. Berbagai upaya dilakukan untuk meminimalisir dampak negatif. *Brain gym* merupakan intervensi alternatif yang banyak digunakan. Serangkaian gerakan antara kaki dan tangan digunakan untuk merangsang otak agar tetap optimal. Penelitian ini bertujuan untuk mengetahui apakah *brain gym* bermanfaat bagi peningkatan kognitif lanjut usia (lansia) di Indonesia. Penelusuran pustaka sistematis dilakukan dari 28 Mei 2020 – 05 Juni 2020 di Semantic Scholar, Google Scholar, Garba Rujukan Digital (Garuda). Proses pencarian menggunakan kata kunci yang disusun menggunakan metode PICOS dan menerapkan penyaringan artikel penelitian uji klinis atau uji coba terkontrol secara acak, diterbitkan dalam lima tahun terakhir, dan literatur pada akses bebas/terbuka. Terdapat 5 artikel yang memenuhi kriteria inklusi: sampel usia 60 tahun ke atas, jenis intervensi *brain gym*, dan fokus penilaian fungsi kognitif menggunakan Mini-Mental State Examination (MMSE), Montreal Cognitive

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Assessment Indonesian Version (MoCA-Ina). Secara keseluruhan, hasil penelitian menunjukkan bahwa partisipan (n=211) mengalami peningkatan fungsi kognitif yang signifikan (p<0,05). Bahkan, ditemukan hasil tambahan berupa penurunan tingkat stres dan peningkatan fungsi aktivitas fisik.
Kata kunci: *brain gym*; kognitif; lansia

INTRODUCTION

The World Health Organization (WHO) defines the elderly as individual or people aged 60 or more years (WHO, 2018). By 2050, one in six people in the world will be over 60 (16%). Regions where the share of the population aged 60 years or over is projected to double between 2019 and 2050, including North Africa and West Asia, Central and South Asia, East and South-East Asia, and Latin America and the Caribbean (Enniza, 2015). As has happened in several countries, Indonesia is also experiencing an increase in the elderly. Based on data from the Central Statistics Agency in 2019, the percentage of the elderly reached 9.60% (Diana Sulis, Adiesty Ferilia, 2017). This shows that Indonesia is a country that will enter the era of an aging population because the number of people aged 60 years and over has exceeded the 7.0% figure. The number of the elderly for each category in Indonesia is respectively elderly (age group 60-69 years), middle elderly (age group 70-79 years), old elderly (age group 80+ years) namely 63.82%, 27.68%, and 8.50% (Amannullah Gantjang, 2019).

One of the most common problems experienced by the elderly is cognitive impairment. The Ministry of Health of the Republic of Indonesia stated that the mildest decline in cognitive function about 39% at aged 50-59 years and then plunge 8.03% more at 80 and over years (Ministry, 2016). The reduction is usually in aspects of orientation, registration, attention, calculation, memory, and speed of thinking (Batista DM, 2017). It greatly affects inability to carry out daily activities, causing dependence on others (Adelina, 2015). Furthermore, there are also changes in thinking power due to a decrease in body systems, emotional changes, and changes in judging something against a certain object (Hukmiyah *et al.*, 2019). Hence, various efforts have been made to minimize the negative impact. One of the exercises as *an intervention that is widely used* is *brain gym exercise. It* is a series of simple motion exercises and is an alternative therapy that aims to accelerate the flow of blood and oxygen to the brain and stimulate both brains to work (Dennison, 2005). *A series of motion between the legs and hands*

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employed to stimulate the brain to remain optimal so that increase in self-confidence, stimulate the right and left brain, relax the brain, and improve cognitive function (Setiawan, Safitri, and Setiyajati, 2014). Indeed, the exercise can improve the cognitive abilities (Hukmiyah *et al.*, 2019), lessen stress level and help to rise physical activity function (Azizah, et al., 2017; Basuki et al., 2018). However, this study aims to investigate whether brain gym exercise is beneficial for cognitive improvement among elderly in Indonesia.

METHOD

The author conducted a systematic literature review in three search engines: Google Scholar, Semantic Scholar, and Garba Rujukan Digital, on 28 May 2020 to 05 June 2020. This study employed keywords refer to PICOS (Population, Intervention, Comparison, and Outcomes) method. They are elderly, brain gym, and cognitive function. The screening process considered the inclusion criteria identified in: research subjects, interventions used and research results. Respectively, covering age 60 years and over, brain gym, and cognitive enhancement. Other aspect including *Clinical Trial* or *Randomized Controlled Trial* (RCT) study design, and year of publication between year 2016 to 2020, and free or open access literature. Then, the articles obtained were checked for duplication using the Mendeley application. However, non-English and non-Indonesian literature were excluded. In detail, data extracted into focus area of the year of publication, research design, subject or sample, name of treatment in the intervention group and comparison group (if any), outcomes, measurement methods, as well as result finding in univariate and bivariate analysis. Research process carried out on three search engines can be seen in the PRISMA figure 1, meanwhile extracted data is available in table 1.

RESULTS AND DISCUSSION

A total 21129 literature were gained from three search engines Garba Rujukan Digital n=4210, Google Scholar n=14200, and Semantic Scholar n=6920. Afterward, recorded was filtered based on respectively criteria the publications of the last five years (period of June 2016 to June 2020) (n=12568), free/open access papers (n=2182), result in n=6379 articles screened. Subsequently, studies were examined by title, abstract, and PICOS. It revealed non-clinical trial and non-randomized controlled trial (RCT) research (n=2117), does not include brain gym exercise intervention (n=3459), and does not include cognitive as research outcome (n=776) to generate 27 eligible citations. Finally, checking process using reference

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software manager called the Mendeley, showed duplication of 11 articles. Hence, 5 literatures are included as final selection for comprehensive review and analysis in this study. During data extraction, skimming and scanning were conducted from the titles, abstract, instrument used, and outcome to justify whether the recoded article complied with the inclusion and exclusion criteria. The result is quantified into percentage of total as can be seen in the table 1.

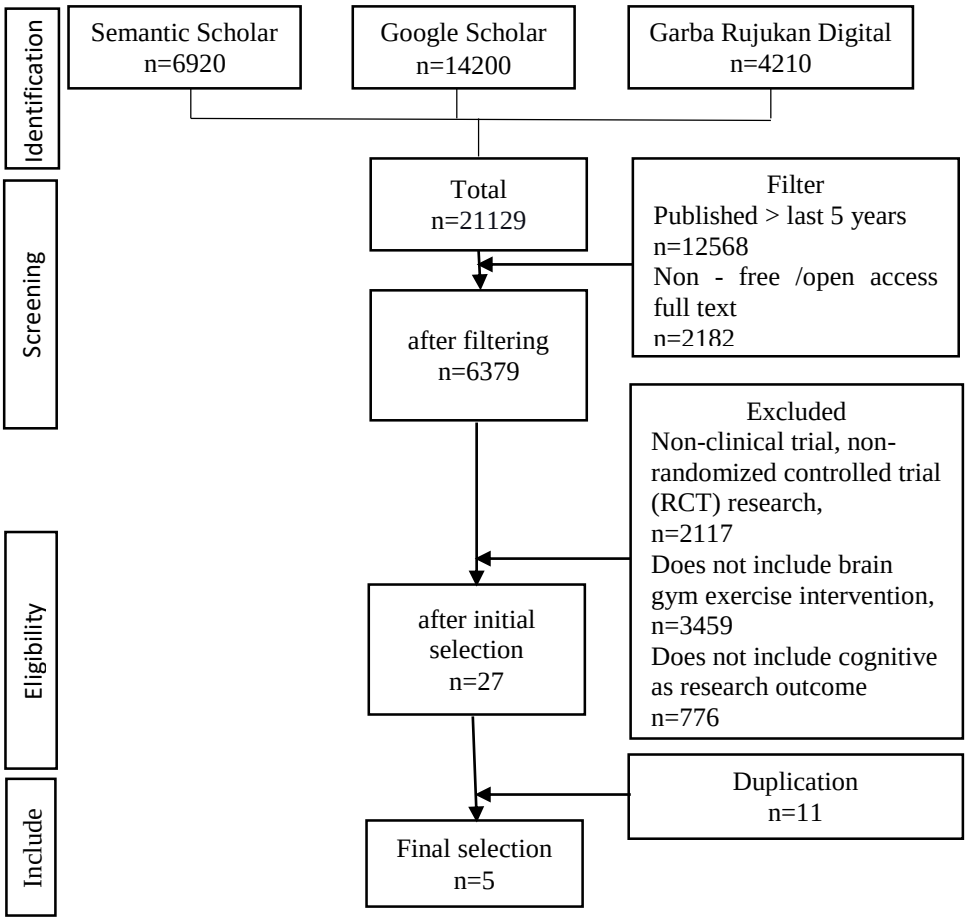

Figure 1. PRISMA Diagram - Flow of the literature search and selection process

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Table 1. Distribution of Study Based on Study Characteristics

Description	%
Research Design: Randomized Controlled Trial	100%
Research Sites: Indonesian	100%
Sample Size	
N = 0 – 35	60%
N = 36 – 70	40%
Sample Age	
>60 years	40%
60 – 75 years	40%
45 – 70 years	20%
Treatment Group	
Brain gym	100%
Elderly exercise	20%
reality oriented activity treatment group	20%
Control group	
Elderly exercise	20%
No treatment	40%
Intervention dose	
a. Duration of Exercise	
15 minutes	40%
45 minutes	20%
60 minutes	20%
b. Frequency of Intervention	
1x per week	20%
2x per week	60%
4x per week	20%
c. Duration of Intervention	
2 weeks	20%
4 weeks	20%
6 weeks	20%
8 weeks	20%
12 weeks	20%
Outcome & Method of Measurement	
MMSE	80%
DASS (Depression, anxiety, and stress)	20%
Plasma brain-derived neurotrophic factor (BDNF) levels	20%
Katz Index	20%
MoCA-Ina	20%
Analysis	
a. Univariate	
Mean	100%
Standard Deviation	100%
b. Bivariate	
Mann Whitney	40%
Wilcoxon	60%
independent t-test	20%

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The research design

Study design used in each literature varies. Nevertheless, 80% of the entire literature employs a clinical trial. They are Azizah, Martiana and Soedirham (2017), Basuki, Haryanto, and Kusumaningrum (2018), Ade Tedi Irawani (2019), and Hukmiyah, *et al.*, (2019). The rest of 20% engages a randomized controlled trial, namely Adriani et al., (2020). Perhaps, this is in accordance with the inclusion criteria of the review. Hence, the validity of the analysis results is guaranteed.

Duration and frequency of each exercise

Related to explanation of exercise duration, Azizah, Martiana and Soedirham (2017) and Hukmiyah (2019), about 40%, practised 15 minutes for each intervention. Whereas, Adriani *et al.* (2020), counted as 20%, carried out the exercise for 60 minutes; Basuki, Haryanto, and Kusumaningrum's research (2018), (20%) employed 45 minutes; Ade Tedi Irawan's research (2019), 20%, has no explanation about duration. In relation to data of the frequency used in the literature, the study of Azizah, Martiana and Soedirham (2017), Basuki, Haryanto, and Kusumaningrum (2018), and Adriani *et al.* (2020), as much as 60%, applied exercise in two times per week. Others, Hukmiyah *et al.* (2019), (20%) did exercise once per week; Ade Tedi Irawan's research (2019), (20%) used frequency four times per week.

Period of intervention

The intervention period of the study samples varied entirely. Ade Tedi Irawan's research (2019), 20%, did intervention for two weeks; Azizah, Martiana and Soedirham (2017), 20%, did intervention for four weeks; Hukmiyah *et al.* (2019), 20%, carried out six weeks intervention; Adriani *et al.* (2020), 20%, organized for 12 weeks intervention; and Basuki, Haryanto, and Kusuma-ningrum (2018), 20%, set intervention for the duration of two months.

Sample size

The number of samples obtained in each study, grouped into two categories interval, between 0-35 respondents (60%) and 36-70 respondents (40%). In respectively, the sample size is 58 respondents in Adriani *et al.* (2020) research (20%), 35 respondents in Azizah, Martiana and Soedirham's (2017) study (20%), 62 respondents in Basuki, Haryanto, and Kusumaningrum's (2018) research (20%), and 30 respondents in Ade Tedi Irawan's (2019) research (20%), 20 respondents in the study of Hukmiyah *et al.*, (2019) (20%).

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Table 2. Characteristics and Literature Details

Author	Participant	Measurements	Treatment	Outcome
(Adriani *et al.*, 2020)	N : 64 Female healthy with age >60 years	MMSE plasma BDNF levels	• Treatment Group (n=32): brain gym exercises. for 60 minutes twice a week for 12 weeks. • Control Group (n=32): Without treatment	BDNF levels increased in both groups after 12 weeks, and there was a significant difference between the treatment group (41.26 ± 6.82 ng/mL) and the control group (37.10 ± 8.11 ng/mL) (p=0.040).
(Hukmiyah *et al.*, 2019)	N : 20 elderly women aged 45 - 70 years	MMSE	• Treatment Group (n = 10): elderly exercise and brain gym exercise. For 15 minutes, once a week for 6 weeks. • Control Group (n=10): elderly exercise. Once a week for 6 weeks	The results showed that there was a significant change in cognitive function between before and after giving brain gym to the intervention group (p<0.05), whereas there was none.
(Irawani and Nuryawati, 2019)	N : 30 Age >60 years	MoCA-Ina	Brain gym. Four times a week for two weeks.	There is an influence of elderly brain gym on cognitive function in the elderly (P value 0.001 < = 0.05).
(Azizah, Martiana and Soedirham, 2017)	N : 35 Age 60-75 years old	MMSE DASS	Brain Gym. Twice a week with a duration of every 15 minutes and carried out in four weeks.	The results showed an increase in cognitive function in the elderly and a decrease in stress levels after brain exercise (p = 0.001 and p = 0.009 at = 0.05).
(Basuki, Haryanto and Kusumaningrum, 2018)	N : 62 Age 60-75 years	MMSE Index Katz	• Treatment Group (n=31): reality oriented activity treatment group and brain gym. for 45 minutes twice a week for 8 weeks. • Control Group (n=31): Without treatment	There was an effect of Elderly Cognitive Care on cognitive function and physical activity of the elderly (p<0.05).

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Output

The enlightenment of *output* in the five kinds of literature, which states that the p-value after treatment is 100%. Meanwhile, there are three kinds of literature that state that there is a mean of 60% Basuki, Haryanto and Kusumaningrum, (2018) (Hukmiyah *et al.*, 2019) and Adriani et al., (2020). There are two kinds of literature as 40% that do not mention the mean, namely Azizah, Martiana and Soedirham (2017) and Ade Tedi Irawani (2019).

Intervention

Affording to the focus of the review, brain gym intervention is a mandatory criterion in all articles. Basuki, Haryanto and Kusumaningrum (2018), Ade Tedi Irawani (2019), Hukmiyah et al. (2019), and Adriani et al. (2020) (accounting for 80% of the total) implemented in the study group accompanied by controls. The rest study (20%), Azizah, Martiana and Soedirham's research (2017), applied brain gym as clinical trial in one group pre-test post-test without control group.

This systematic review provides an overview of the effectiveness of brain exercise on improving cognitive function among elderly aged 60 and more years. Disparities in the implementation of interventions and measurements in the research process, whether using controls or not, do not reduce the effectiveness value produced statistically. Research conducted by Azizah, Martiana and Soedirham, (2017) analyzed the effectiveness of brain exercise in improving cognitive function and reducing stress levels in the elderly using two measuring tools, namely stress levels using the Depression Anxiety Stress Scale (DASS), and for mental use using a mini mental state examination (MMSE). The results showed an increase in cognitive function in the elderly and a decrease in stress levels after brain exercise ($p = 0.001$ and $p = 0.009$ at $= 0.05$). Whereas research by Basuki, Haryanto, and Kusumaningrum, (2018) assessed the effectiveness of improving cognitive function and physical activity in the elderly with the MMSE and Katsz Index resulting in a significance p value = 0.02.

On the other hand, Ade Tedi Irawani's research (2019) shows the effect of brain exercise on cognitive function in the elderly using the MoCA-Ina measuring instrument. The results of statistical calculations with Mann Whitney resulted in a significance of p value = 0.001. This result is still expected to increase further in the next measurement. This is based on the theory when brain exercise is carried out continuously on a regular basis, the results will be much more effective. Brain exercise movements can activate three dimensions of the brain,

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where the concentration dimension can increase blood flow to the brain, increase oxygen reception, the lateral dimension will stimulate the coordination of the two hemispheres of the brain, namely the right and left brain, increase breathing, stamina, release tension and reduce fatigue. The focusing dimension is to remove the inhibition of concentration from the brain. Thus, it can improve the lack of attention and lack of concentration. ultimately help facilitate the improvement of the cognitive function of the elderly. Therefore, it can be said that brain exercise activities are very helpful in overcoming the problem of cognitive decline in the elderly. Indeed, research by Hukmiyah et al. (2019), showed a significant difference before and after giving brain exercise to the study group and the control group, p=0.016 ($p<0.05$) in the intervention group, while p=0.74 ($p>0.05$) in the control group. . This value is generated from processing the data obtained with two instruments, namely MMSE and Plasma brain-derived neurotrophic factor (BDNF). Brain exercise training was carried out for 12 weeks. This increase in cognitive function is caused by the activity of BDNF in the form of a protein found in high concentrations in the central nervous system, especially in the hippocampus, cerebral cortex, hypothalamus, and cerebellum. BDNF plays an important role in the growth and endurance of nerves that affect learning and memory.

Physiologically, it can be said that the movement in brain gymnastics plays a role in the cardiovascular, metabolic, and nervous systems. It starts with an increase in blood circulation which helps increase oxygen in the blood. Furthermore, the process carry out in the nervous system, in the form of mechanotransduction, a process of body mechanical movement followed by cellular response. This process generally goes through three stages. First, mechanocoupling. Represents the process of identifying the load by the receiving nervous system about what muscle systems are working and at what intensity. All of them are collected, accumulated and conveyed on the outer surface of the cell until it enters the inner surface of the cell and is converted into a message that needs a response. Second, communication between cells to the brain. Describes the process by which a load-taking cell on the inner surface of the cell informs and passes it on to a messenger cell to carry a message to the brain until it is processed and a solution is determined. Third, the effector cell response. Illustrate that the response to the previous message is carried and acted upon by the return message bearer named the effector. Follow-up responses are carried out according to the needs of the

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message. In general, in the form of repair and maintenance of cells (Khan and Scott, 2009; Huang *et al.*, 2013; Ng *et al.*, 2017). Thus, it has an impact on the metabolic system that can be observed in the body's physiological system as seen on the barometer of vital sign measurements.

CONCLUSION

In short, brain gym has proven its effectiveness to improve cognitive function in the elderly in various studies that modify the technical intervention, but with doses that are still adjusted to the needs of the elderly. This can be used as a reference for program developers to implement in the community, to make sure every elderly stays fit, productive, and happy.

REFERENCES

Adriani, D. D. *et al.* (2020) 'Effect of Brain Gym ® exercises on cognitive function and brain-derived neurotrophic factor plasma level in elderly: a randomized controlled trial', *Universa Medicina*, 39(1), pp. 34–41. doi: 10.18051/UNIVMED.2020.V39.34-41.

Adelina, M. E. (2015). pengaruh metode brain gym terhadap kemampuan motorik kasar anak kelompok B, (September), 16–19.

Amannullah Gantjang (2019) Badan Pusat Statistika 2019. Jakarta: Badan Pusat Statistik. Available at: https://www.bps.go.id/.

Azizah, L. M., Martiana, T. and Soedirham, O. (2017) 'The Improvement of Cognitive Function and Decrease the Level of Stress in the Elderly with Brain Gym', *International Journal of Nursing and Midwifery Science (Ijnms)*, 1(1), pp. 26–31. doi: 10.29082/ijnms/2017/vol1/iss1/33.

Basuki, H. O., Haryanto, J. and Kusumaningrum, T. (2018) 'The Effect of Elderly Cognitive Care on the Cognitive Function and Physical Activity of Elderly', *Indonesian Journal of Health Research*, 1(2), pp. 37–48. doi: 10.32805/ijhr.2018.1.2.16.

Batista DM, G. (2017) 'Pengaruh Terapi Latihan Otak terhadap Peningkatan Fungsi Kognitif pada Lansia', SciFed Dental & Oral Research Journal, (diakses pada 29 November 2019). doi: 10.23959/sfdorj-1000017.

Dennison, P. E. and Dennison, G. E. (2011) 'Edu-K Style Guide : The Style and Standards of Educational Kinesiology'.

Departement of Health of England (2014) *Delivering high quality, effective, compassionate care: Developing the right people with the right skills and the right values*. Available at: www.nationalarchives.gov.uk/doc/open-government-licence/ (Accessed: 4 March 2022).

Dewi, S. R. (2016) 'Pengaruh Senam Otak dan Bermain Puzzle terhadap Fungsi Kognitif Lansia di PLTU Jember', Jurnal Kesehatan Primer, 1(1), pp. 64–69.

Diana Sulis, Adiesty Ferilia, M. E. (2017). Brain Gym (Stimulasi Perkembangan Anak Paud I). (Perdana Riza, Ed.), Journal of Experimental Psychology: General (1st ed., Vol. 136). Perum

Triyagan Regency Blok A No 1, Mojolaban: maret 2017.

Enniza, K. (2015). Pengaruh Brain Gym Terhadap Kreativitas Anak Usia 5-6 Tahun Di Tk Aba Sidoharjo, Turi, Sleman, Yogyakarta, 9–43.

Huang, C. *et al.* (2013) 'Mechanotherapy: Revisiting physical therapy and recruiting mechanobiology for a new era in medicine', *Trends in Molecular Medicine*, pp. 555–564. doi: 10.1016/j.molmed.2013.05.005.

Hukmiyah, A. N. *et al.* (2019) 'Pemberian Brain Gym Exercise Dapat Meningkatkan Fungsi Kognitif Pada Lanjut Usia', *Jurnal Vokasi Indonesia*, 7(2), pp. 11–18. doi: 10.7454/jvi.v7i2.148.

Irawani, A. T. and Nuryawati, L. S. (2019) 'Pengaruh Brain Gym Lanjut Usia Terhadap Fungsi Kognitif Pada LAde Tedi Irawan, lina siti nuryawati. (2019). Pengaruh Brain Gym Lanjut Usia Terhadap Fungsi Kognitif Pada Lanjut Usia Di Uptd Puskesmas Majalengka Kecamatan Majalengka Wetan Kabupaten Majaleng', *Journal of Chemical Information and Modeling*, 53(9), pp. 1689–1699. Available at: file:///C:/Users/User/Downloads/fvm939e.pdf.

Kementrian, K. (2016) Profil Kesehatan Indonesia, Kementrian Kesehatan. Available at: https://www.kemkes.go.id/resources/download/pusdatin/lain-lain/Data dan Informasi Kesehatan Profil Kesehatan Indonesia 2016 - smaller size - web.pdf.

Khan, K. M. and Scott, A. (2009) 'Mechanotherapy: How physical therapists' prescription of exercise promotes tissue repair', *British Journal of Sports Medicine*, pp. 247–252. doi: 10.1136/bjsm.2008.054239.

Ng, J. L. *et al.* (2017) 'Establishing the basis for mechanobiology-based physical therapy protocols to potentiate cellular healing and tissue regeneration', *Frontiers in Physiology*. Frontiers Media S.A. doi: 10.3389/fphys.2017.00303.

Setiawan, R. A., Safitri, W. and Setiyajati, A. (2014) 'Pengaruh Senam Otak dengan Kognitif Lansia', (diakses pada 5 Desember 2019). Available at: http://digilib.stikeskusumahusada.ac.id/files/disk1/13/01-gdl-rochmadagu-624-1-artikel.pdf.

World Health, O. (2018) 'Ageing and Health'. Available at: https://www.who.int/ News-Room/Fact-Sheets/Detail/Ageing-Andhealth.

DOI: 10.32668/jitek.v9i2.543