ORIGINAL ARTICLE

The Improvement of Neuropathy and Balance after Combination of Indonesian Diabetic and Indonesian Diabetic Foot Exercise on Diabetic Peripheral Neuropathy

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ABSTRACT

Background: Half of people with Type 2 Diabetes Mellitus (Type 2 DM) developed diabetic neuropathy at 25 years after being diagnosed and around 75% of the neuropathy were diabetic peripheral neuropathy (DPN), that associated with balance disturbance. This study aimed to know the effect of combining Indonesian diabetic exercise (Senam Diabetes Indonesia/SDI) and Indonesian diabetic foot exercise (Senam Kaki Diabetes Indonesia/SKDI) on improvement of diabetic neuropathy and balance score in people with Type 2 diabetic peripheral neuropathy.

Methods: Design study was a quasi-experimental study with pre-posttest design. The participants were Type 2 DM patients aged 40-65 years old, with DPN confirmed based on Indonesian version of Diabetic Neuropathy Symptom (DNS-INA) ≥1 or Indones ian version of Diabetic Neuropathy Exmination (DNE-INA) >3, who did not do exercise regularly. All participants had Berg Balance Scale (BBS) score within 41-55, and the random peripheral blood glucose within 100-250mg/dL. The BBS, DNE-INA, and DNS-INA score were evaluated before and after 12 weeks of excercise.

Results: There were 6 women aged 52-65 years. The mean of BBS, DNS-INA, and DNE-INA scores before and after intervention were 54.33±1.032 and 55.16±1.329 (p=0.025), 2.50±1.048 and 1.50±0.836 (p=0.063), 3.66±1.505 and 1.33±0.816 (p=0.041), respectively.

Conclusion: There were improvement of Berg Balance Score and Diabetic Neuropathy Score after the combination of Diabetic exercises.

Keywords: *Berg Balance Score, diabetic neuropathy score, Indonesian Diabetic Exercise, Indonesian Foot Diabetic Exercise*

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INTRODUCTION

The incidence and prevalence of Type 2 Diabetes Mellitus (Type 2 DM) in Indonesia have increased in recent years. World Health Organization (WHO) predict DM prevalence in Indonesia will increase from 8.4 million (year 2000) to 21.3 million (year 2030)[1], which is 90—95% are Type 2 DM.[2] From previous study found that half of people with Type 2 DM developed diabetic neuropathy (DN) on 25 years after being diagnosed, with 75% of DN is diabetic peripheral neuropathy (DPN)[3].

Diabetic peripheral neuropathy associated with balance problem caused by sensory nerve impairment, that is essential in motor performance impairment (lower muscle unit, weakness, less endurance, less force production rate).[3-8] Hyperglycemia causes mild chronic inflammatory caused metabolic and micro vascular disturbance. Besides, there were increasing of oxidative stress, polyol pathway, protein kinase C, and AGE, promote the decrease of nerve blood flow and endothelial function, then followed by impaired of mitochondrial bioenergetics, that have consequences on neuronal and skeletal muscle cell dysfunction.[5] Subjects with neural and skeletal muscle disfunction have poor balance, that may interfere gait and postural control, and increased the risk of falling, and decrease the quality of life.[5-7] The fact has been proven by previous study, that subject with DM have 2.5 folds higher of the risk of fall than non DM, the risk rises until 17 folds if there is peripheral neuropathy.[6] The Diabetic peripheral neuropathy can evaluated by Indonesian version of Diabetic Neuropathy Symptom (DNS-INA) and Indonesian version of Diabetic Neuropathy Examination (DNE-INA) score. As mention above that DPN may interfere postural balance control, that can assessed by Berg Balance Score (BBS).[9-10]

Physical exercise is one of the pillars of managing DM in Indonesia.[2] It has been hypothesized that exercise will reduce DPN progression by increasing the glucose transporters, thus increasing glucose uptake and improve mitochondrial function, by activation of nitric oxide production. Increasing of nitric oxide promotes micro vascular dilatation and reduces oxidative stress and increases the neurotrophic factors.[5-8,11]

Based of that theory, Indonesian diabetes organization developed Indonesian Diabetic Exercise (Senam Diabetes Indonesia/SDI) and Indonesian Diabetic Foot Exercise (Senam Kaki Diabetes Indonesia/SKDI). From previous studies, Indonesian diabetic exercise and diabetic foot exercise were showed the improvement of glycemic control[12,13,14], blood circulation on foot. [15,16] and neurotrophin-3 (NT-3)[17]. The combination of both exercise predicted increase the effect on improvement of peripheral neurovascular in people with Type 2 DM.[18] However, there has still lack of study in analyzed the combination of both exercises in improvement of the peripheral neurovascular and the balance control in patient with DPN. The aimed of this study is to find the improvement of DPN and balance after the combination of Indonesian diabetic and Indonesian diabetic foot exercise intervention.

METHODS

Design study was a quasi-experimental study with pre-posttest design and samples conducted

from February until May 2017. Participants were recruited from primary health care (Puskesmas Pasir Kaliki and Sukajadi). Subjects were type 2 DM, have sedentary life, age of 40—65 years. Assesment of lower limb DPN by Indonesian version of Diabetic Neuropathy Symptom (DNS-INA) score ≥1 and Indonesian version of Diabetic Neuropathy Examination (DNE-INA) score >3. Evaluation of postural balance control was by Berg Balance Scale (BBS) in range of scale between 41-55. Subjects have a good cognitive function that confirmed by Mini Mental State Examination (MMSE) score 24 and above. Subjects have a random peripheral blood glucose level between 100-250mg/dL, and agree to participate in this study. [9-10]

Exclusion criteria were subjects with foot ulcer, cardiovascular disease, musculoskeletal injury and disease that may interfering exercise movement, history of stroke or other central nervous system disease, uncorrected visual problem, and orthostatic hypotension. All subjects have combination of Indonesian diabetic and Indonesian diabetic foot exercise in one group three times a week for twelve weeks at Hasan Sadikin Hospital. Exercised was guided by certified instructor. Evaluation was done after twelve weeks that was taken one day after the last exercise.

Indonesia diabetic exercise consist of warming up, main exercise 1, followed by exercise 2, and cooling down, whereas approximately 7 minutes for each part. Exercise was done in standing position without equipment. Movement is mostly marching and stepping movement to various direction, approximately 80-90 steps per minute accompanied by upper limb movement. Cooling down and some part of warming up were stretching. Six variations of this exercise were randomly applied.

The Indonesian foot diabetic exercise was done in sitting position, consisted of ten repetitions of toe flexion in ankle dorsiflexion, toe rises and heel rises, open chain and closed chain ankle rotation, toe flexion and extension in knee extension, drawing imaginary number 0 to 9 on air. Next movement is making ball from a sheet of newspaper using both foot than flattened it again, the newspaper shredded into small pieces using feet, lastly was making ball from the small pieces of newspaper using feet.

Data were analyzed using Statistical Package for the Social Sciences (SPSS) software (version 24.0) for Windows. Minimal sample for confidence interval of 95% and power test 75% are 6 participants. The normality distributions were checked using Shapiro Wilk test. Paired t-test was used to compare scores (DNS-INA, DNE-INA, BBS) before and after intervention. p value ≤ 0,05 is considered statistically significant. Ethical approval was obtained from Health Research Ethic Committee of medical faculty Padjajaran University.

RESULTS

All of the subjects were women that have occupation as housewives, mean of aged 58,33 years old. The mean duration of DM was 6 years with mean BMI was 24.19 kg/m^2.

Table 1. Demographic Data

Numerical Variable	Mean±SD n = 6	Range n = 6
Age	58,33±4,457	52,00-65,00
Duration of DM (Year)	6,00±4,816	1,00-13,00
Body Mass Index (kg/m^2)	24,19±5,001	18,07-30,44
Occupation: Housewife	6 (100%)	

SD = Standard Deviation, n = number of participants

Comparison of scores (DNS-INA, DNE-INA, BBS) before and after intervention was present in Table 2. There was significant improvement of BBS after the intervention (p=0.025), while improvement of the DPN was found by reducing of DNS-INA and DNE-INA score after the intervention, although the differences of DNE-INA (p=0.041) score was stronger than the differences of DNS-INA (p = 0.063).

Table 2. DNS-INA, DNE-INA, BBS Score Before And After Intervention

Time of examination	Parameter	Variable		
		DNS-INA n = 6	DNE-INA n = 6	BBS n = 6
Before	Mean±SD	2.50±1.048	3.66±1.505	54.33±1.032
After	Mean±SD	1.50±0.836	1.33±0.816	55.16±1.329
p value		0.063	0.041*	0.025*

* t-test

DISCUSSION

The total participants of this study were all housewife sedentary women with aged more than 50 and below 60 years old, the mean duration of DM were 6 years, and the mean of BMI were overweight, also had a DPN. This study showed that the subjects were homogeneous.

All of subjects have exercise intervention by combine diabetes exercise for 12 weeks. There were improvement in diabetic neuropathy evaluated by DNS-INA and DNE-INA Score. However, the improvement of DNE-INA Score (p=0.041) was stronger than DNS-INA score (p=0.063). The result might have correlation with the assessment of DNE-INA that more objective

than DNS-INA. The result data was supported by Wahyuni that has proven the improvement of foot paresthesia after the combination of Indonesian diabetic and Indonesian diabetic foot exercises.[18] Regular exercise induces suppression of TNF-alpha by increasing IL-6 that stimulates other anti-inflammatory cytokines such as IL-Ira and IL-10.[19] Exercise also improved DPN via metabolic and microvascular key pathway by activating nitro oxide production which is the key recovery of vascular endothelium function in DPN, decrease oxidative stress and inhibit aldose reductase, followed by improving hypoxia in nerve fiber, thus decreasing the symptoms of neuropathy.[5]

The study of postural balance after 12 weeks of combine exercise, revealed the improvement of postural balance, that showed in increasing of Berg Balance Score. In fact, the Indonesian diabetic exercise alone is not specifically for balance training, although consist of stepping movement to various direction, therefore could stimulated and improved muscle strength that great contributor in balance improvement. This result study inline by the study by Dharmmika, that has shown no improvement on balance in subjects with DPN who only got the diabetic foot exercise alone without Indonesian diabetic exercise. [20]

The study has shown Indonesian foot diabetic exercise will improve glycemic control, increase foot blood circulation, and increase neurotrophin (NT-3)[14-17] as an important role in regulating neuronal to survive and plasticity. Increasing of muscle neurotrophin levels such as NT-3 mRNA will improve proprioceptive neurons and muscle spindle formation. Other neurotrophin may be improve after exercise is the brain-derived neurotrophic factor (BDNF), that has been identified as a key component of the hypothalamic pathway that controls body weight and energy homeostasis.[21] The BNDF also appears to have important role in central metabolic pathways, skeletal muscle metabolism, insulin resistance and in energy balance. Individuals with both obesity and type 2 DM have low levels of BDNF, by inhibits cerebral output of BDNF. The BDNF mRNA and the protein expression were increased in human skeletal muscle after exercise and increase fat oxidation. Otherwise, the exercise also increasing the size and degree of branching of motor nerve terminals at the neuromuscular junction, increasing the total area of both pre- and postsynaptic elements, and the amount of Acetylcholine (ACh) released. These factors improve nerve function and muscle performance that is important in balance control.[19] Further study needed to found the effect of combine exercises on neurotrophin level in subject with type 2 DM.

Limitation of the study was without control group.

CONCLUSION

Combination of Indonesian diabetic exercise and Indonesian diabetic foot exercise were effective to improve neuropathy and balance in subjects with DPN.

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