

Handgrip strength of community-dwelling elderly in Nakhon Ratchasima Province, Thailand

Jitwadee Horpibulsuk,¹ Wannisa Nutkhum² and Pornsiri Jongjol²

¹School of Internal Medicine, Institute of Medicine, ²School of Industrial Engineering, Institute of Engineering, Suranaree University of Technology, 111 University road, Muang, Nakhon Ratchasima

Objective To investigate handgrip strength (HGS) in Thai elderly living in Nakhon Ratchasima Province, Thailand, and to examine factors related to HGS.

Methods In this is a cross-sectional analytical study, participants were elderly individuals (age >60 years) living in Nakhon Ratchasima, Thailand. Demographic characteristics, anthropometric measurements, and Barthel Activities of Daily Living index (ADL) were recorded. Assessment of grip strength of the dominant hand was conducted following standardized testing procedures of the American Society of Hand Therapists.

Results The mean age ($\pm$ SD) of the 491 participants was 69.15 ± 6.86 years. The mean HGS for male participants was significantly higher than for females (24.93 ± 7.45 vs 16.17 ± 4.82 , $p < 0.001$), but there was a significant decline in HGS with age in both genders ($r = -0.310$, $p < 0.01$). Dividing participants by BMI found that normal and overweight individuals had a higher HGS than underweight participants ($p < 0.001$).

Conclusion As age increases, the HGS of both males and females declines. Elderly males have a higher HGS than females. Elderly (age ≥ 60 years) of both genders have a statistically significantly higher HGS than underweight individuals. *Chiang Mai Medical Journal* 2019;58(1):15-22.

Keywords: HGS, Thai elderly, BMI, community

Introduction

Fifty years ago in Thailand, the proportion of the population age years 60 or over was relatively small. By 2014, the number of elderly had reached 10 million, or 15% of the total. In 2005, Thailand reached the demographic criteria for being labeled an “aged society” as the proportion of the total population age 60 years or over had reached 10%. It is projected that Thailand will achieve the status of a “complete aging society” in 2021 when the elderly proportion reaches 20%. It is further

projected that Thailand will achieve “super-aged society” status (28% of the population elderly) within the coming 20 years by 2036 (1).

The process of aging is characterized by the presence of body changes that affect the functional and cognitive ability of the individual. Over time, there is a gradual decrease in functional capacity which prevents an individual from performing some basic tasks and activities. Evaluation of elderly with respect to muscular strength as well as other functional tests has been highly recommended

Correspondence: Jitwadee Horpibulsuk, School of Internal Medicine, Institute of Medicine, Suranaree University of Technology, Nakhon Ratchasima 30000 Thailand.
E-mail: Jitwadee@sut.ac.th

Received: February 4, 2018, **Revised:** April 19, 2018; **Accepted:** August 7, 2018



(2). In the context of muscle strength, healthcare professionals assess handgrip strength (HGS), which is defined as the maximum voluntary force an individual can apply with his/her hand. It is a common method for estimating total body muscle strength (3) which has been utilized across various clinical settings, in particular to assess nutritional risk among hospitalized patients (4,5) and as an indicator to assess the nutritional status of non-hospitalized patients (6). Low HGS has been associated with functional disability (7,8), chronic illness (9-12), longer hospital stay (13,14), and mortality (3,15). HGS is an effective method for assessing muscle strength of elderly members of a population. In 2014, Thai National Health Examination Survey found that most individuals aged 60-69 years had moderate HGS and those 70-79 years had very low HGS (16). Since the previous that study surveyed the population only in one particular area in Thailand, results might differ in other areas. This study aimed to investigate HGS in community-dwelling elderly living in Nakhon Ratchasima Province, Thailand and to assess aspects related to HGS.

Methods

Subjects

The elderly population (≥ 60 years) in Nakhon Ratchasima Province numbered 376,813 in 2011. Using the Taro Yamane method, the sample size required for a 95% confidence interval and a $\pm 5\%$ error was 400 (17). A total of 491 elderly participants, all above 60 years old, were recruited for this cross-sectional analytic study from 17 districts in Nakhon Ratchasima: Pak Thong Chai, Chalerm Prakiat, Sri Kiew, Kornburi, Muang, Soong Noen, Pak Chong, Chakra, Non Thai, Chok Chai, Huay Talang, Non Soong, Wang Na Khieow, Kham Thale Sor, Nong Boon Mak, Kham Sage Saeng and Kong. All participants signed an informed consent form and the study was approved by the Research Ethic Committee of Suranaree University of Technology, Nakhon Ratchasima, Thailand.

Demographic data

Recorded demographic characteristics of participants included education, age, gender, health-related behaviors, comorbid conditions, and activities such as alcohol consumption and smoking.

Anthropometry

Mid-upper arm circumference, waist circumference, hip circumference, calf circumference, height, and weight of each participant were measured using standard methods (18). The Body Mass Index (BMI) of each participant was calculated based on standard methodology. Participants were then classified based on their BMI values as follows: obese ($\text{BMI} \geq 30 \text{ kg/m}^2$), overweight ($\text{BMI} 25\text{-}29.99 \text{ kg/m}^2$), normal ($18.5\text{-}24.99 \text{ kg/m}^2$), and underweight ($\text{BMI} < 18.5 \text{ kg/m}^2$) (19).

Physical activity

The amount of physical activity engaged in was assessed and calculated based on self-reported levels of exercise in the previous 30 days. Functional disability measures included activities appearing in the Barthel Activities of Daily Living Index (ADL) (20). This data was used by researchers to assess the overall functional disability of each participant. Each participant was categorized based on ADL items and ADL limitations.

Handgrip strength

HGS was assessed using standard testing procedures as the American Society of Hand Therapists (21) using a Jamar handheld dynamometer. Each of the participants had the HGS of their dominant hand measured. The average of two readings was recorded in kilograms.

Analysis

Descriptive statistics were used to portray general information of the collected data. The mean HGSs of participants of each gender were compared within each age group by independent t-test. HGS was compared by BMI group using One-way ANOVA and the Bonferroni post hoc test. Pearson correlations were computed for

HGS, age, and BMI. Multiple linear regression analyses were carried out with HGS as a dependent variable and age, gender, and BMI as independent control variables. All data were analyzed using the Statistical Package for Social Science (SPSS) version 18 program for Windows.

Results

Among the 491 elderly participants, nearly all had completed primary school (88%). Most of the participants lived in rural areas (81.7%) and most rated their overall health condition as median level (53%), very strong (20.2%), or fairly strong (12.4%). When asked to compare their own strength to that of other individuals of the same age and gender, 42.4% thought they were stronger than the others, while 40.1% thought they were equally strong. (Baseline characteristics of the participants are shown in Table 1).

Comparing male and female participants, it was found that male participants were significantly taller, heavier, and had a higher HGS than females ($p<0.001$) (Table 2).

Comparison of the mean HGS among three age groups (60-69, 70-79, ≥ 80) found that on average older participants had lower HGS than younger participants ($p<0.05$). Similarly, there was a gradual decline in BMI as age increased ($p<0.05$) (Table 3). Based on the standard HGS from the Sports Authority of Thailand (16), most of the participants had very low HGS (Table 4).

Age was a negatively correlated with HGS ($r=-0.31$, $p<0.001$) (Figure 1), but BMI was positively correlated with HGS ($r=0.174$, $p<0.001$) (Figure 2).

Among all participants and among male participants, normal and overweight individuals had a significantly higher HGS than those who were underweight (Figure 3).

Table 1. Baseline characteristics of participants by gender, n (%) or mean $\pm$ SD

Parameter	Total	Female	Male
Number	491 (100%)	321 (65.4%)	170 (34.6%)
Age (years)	69.15 $\pm$ 6.86	69.21 $\pm$ 6.79	69.02 $\pm$ 7.02
Comorbidities			
Arterial hypertension	185 (37.7%)	113 (35.2%)	72 (42.4%)
Low back pain	136 (27.7%)	90 (28.0%)	46 (27.1%)
Osteoporosis	128 (26.1%)	85 (26.5%)	43 (25.3%)
Osteoarthritis	100 (20.4%)	72 (22.4%)	28 (16.5%)
Eye diseases	92 (18.7%)	57 (17.8%)	35 (20.6%)
Diabetes mellitus	77 (15.7%)	63 (19.6%)	14 (8.2%)
Coronary arterial disease	35 (7.1%)	23 (7.2%)	12 (7.1%)
Cerebrovascular disease	4 (0.8%)	1 (0.3%)	3 (1.8%)
Current smoking	62 (12.6%)	1 (0.3%)	61 (35.9%)
Current alcohol drinking	47 (9.6%)	21 (6.5%)	26 (15.3%)
Current medication	300 (61.1%)	197 (61.4%)	103 (60.0%)
Current exercise	246 (50.1%)	152 (47.4%)	94 (55.3%)
Height (cm)	153.08 $\pm$ 7.54	149.70 $\pm$ 5.83	159.44 $\pm$ 6.19
Weight (kg)	53.07 $\pm$ 10.73	51.14 $\pm$ 10.42	56.72 $\pm$ 10.38
BMI (kg/m ²)	22.58 $\pm$ 3.94	22.75 $\pm$ 4.12	22.26 $\pm$ 3.58
MUAC (cm)	28.36 $\pm$ 12.48	28.22 $\pm$ 15.15	28.62 $\pm$ 4.06
Waist circumference (cm)	81.23 $\pm$ 10.17	81.51 $\pm$ 10.42	80.71 $\pm$ 9.67
Hip circumference (cm)	92.78 $\pm$ 9.22	93.89 $\pm$ 9.16	90.67 $\pm$ 8.98
Calf circumference (cm)	32.23 $\pm$ 7.96	31.87 $\pm$ 9.54	32.91 $\pm$ 3.29
HGS (kg)	19.21 $\pm$ 7.19	16.17 $\pm$ 4.82	24.93 $\pm$ 7.45
ADL	19.44 $\pm$ 1.38	19.40 $\pm$ 1.13	19.52 $\pm$ 1.77

n; number, SD; standard deviation, BMI; body mass index, MUAC; mid-upper arm circumference, HGS; handgrip strength, ADL; Barthel Activities of Daily Living index

Table 2. Summary of main variables of participants by gender

	Female (n=321)	Male (n=170)	<i>p</i> -value
	Mean±SD	Mean±SD	
Age (years)	69.21±6.78	69.02±7.02	0.76
Height (cm)	149.71±5.82	159.44±6.19	<0.001
Weight (kg)	51.14±10.42	56.72±10.38	<0.001
BMI (kg/m ²)	22.75±4.11	22.26±3.58	0.19
HGS (kg)	16.17±4.82	24.93±7.45	<0.001

BMI: body mass index; HGS: handgrip strength

Table 3. Mean and standard deviation of HGS and BMI by gender and age group

Variable	Femail			Male			<i>p</i> -value
	n	Mean	SD	n	Mean	SD	
HGS (N)							
60-69 years	181	17.8 a,b	4.7	90	27.9 ^{a,b}	7.4	<0.001
70-79 years	119	14.2 a	4.2	61	22.5 ^{a,c}	5.9	<0.001
80 years or older	21	13.2 b	3.2	19	18.5 ^{b,c}	5.4	0.001
Total	321	16.2	4.8	170	24.9	7.4	<0.001
BMI (kg/m ²)							
60-69 years	181	24.0 a, b	4.0	90	23.2 ^{a, b}	3.6	0.110
70-79 years	119	21.4 a	3.8	61	21.8 ^{a,c}	3.1	0.428
80 years or older	21	19.9 b	3.2	19	19.3 ^{b,c}	2.6	0.522
Total	321	22.8	4.1	170	22.3	3.6	0.189

^aStatistically significant difference between the groups aged 60-69 and 70-79 years

^bStatistically significant difference between the groups aged 60-69 and 80 years or older

^cStatistically significant difference between the groups aged 70-79 and 80 years or older

Table 4. HGS to body weight ratio of participants by gender

HGS to BW (kg/kg)	Male		Female	
	Standard value	n (%)	Standard value	n (%)
Very good	≥ 0.65	8 (4.7)	≥ 0.49	11 (3.4)
Good	0.60-0.64	7 (4.1)	0.45-0.48	22 (6.9)
Moderate	0.49-0.59	36 (21.2)	0.36-0.44	81 (25.2)
Low	0.44-0.48	33 (19.4)	0.32-0.35	45 (14.0)
Very low	≤ 0.43	86 (50.6)	≤ 0.31	162 (50.5)

HGS; handgrip strength, Kg; kilogram, BW; body weight

Among female participants, those with a BMI classified as obese had highest HGS. Participants whose BMI classification was normal, overweight, or obese had higher HGS than those who were underweight. Overweight individuals had a significantly higher HGS than participants of normal weight (Figure 3).

Gender and BMI were both positively correlated with HGS, while age was negatively correlated with HGS. Results of multiple linear regression analysis are summarized in Table 5.

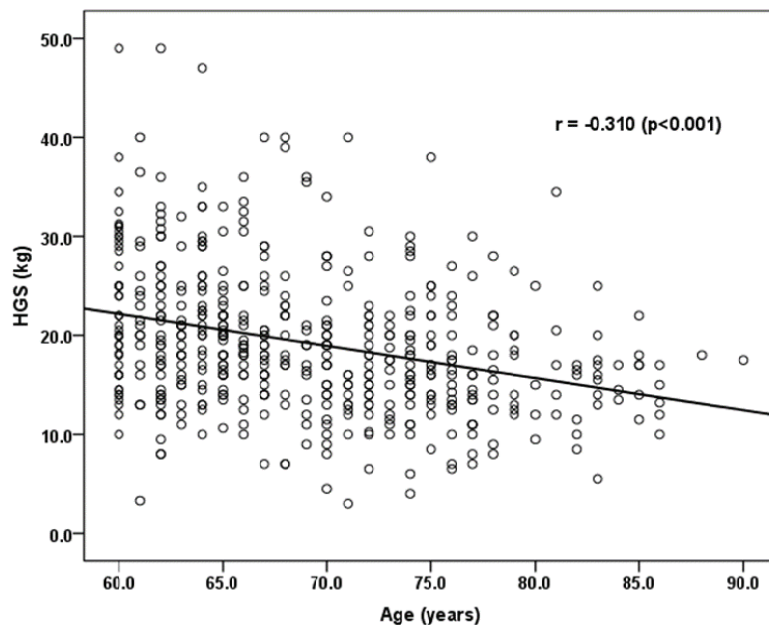


Figure 1. Correlation between age and HGS

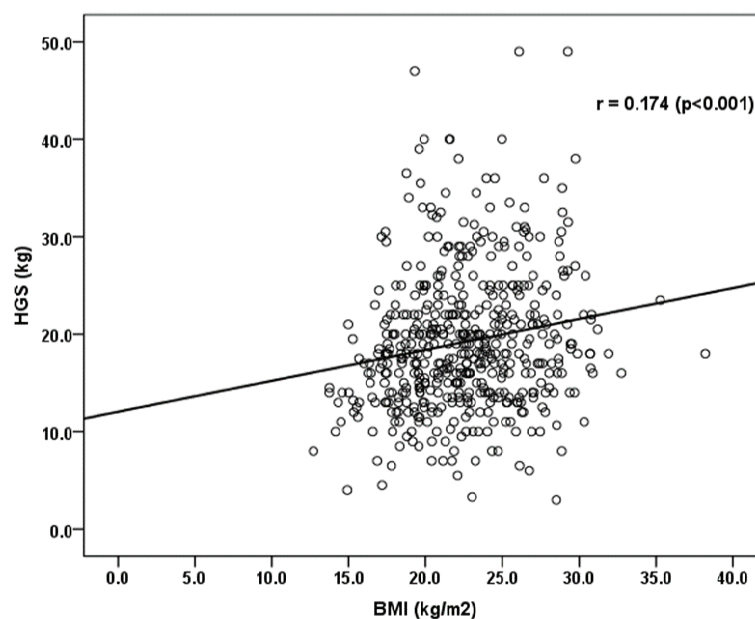


Figure 2. Correlation between BMI and HGS

Discussion

Anthropometric data showed that male participants had statistically significantly higher height and body weight than female participants ($p < 0.001$). These findings are similar to results in previous studies (22–25), indicating that gender has an influence on body proportions.

The mean HGS of male participants was significantly higher than female participants ($p < 0.01$), similar to previous studies (25,26). For the three age groups studied, male participants in every age group had significantly higher HGS than female participants ($p < 0.01$). These findings may be due to the fact that males on average have greater reserves of muscle mass than females (26).

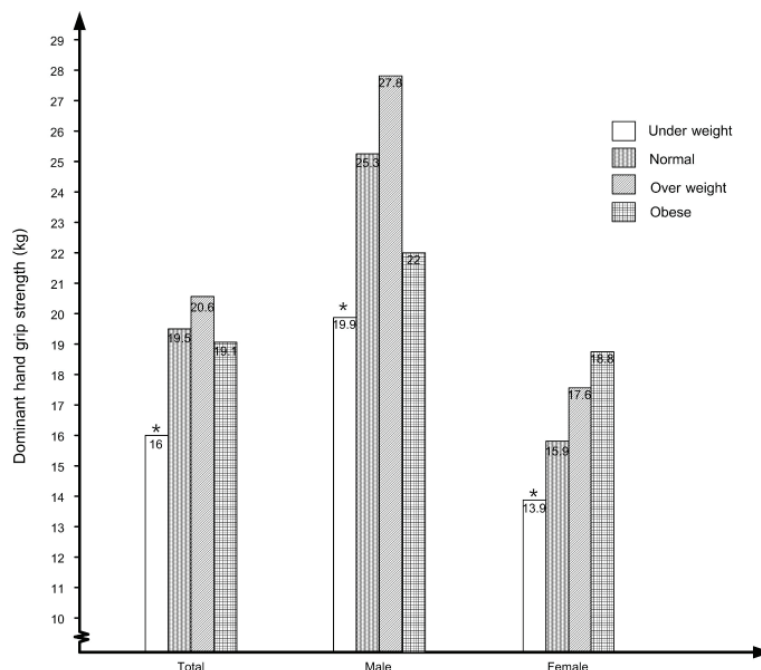


Figure 3. HGS of participants by BMI category
*as all are equally statistically significant ($p < 0.01$)

Table 5. Results of the multiple linear regression analysis with HGS as dependent variable

	Regression coefficient	95%CI		p-value
		Lower	Upper	
Male	9.09	8.10	10.08	<0.001
Age (year)	-0.32	-0.39	-0.25	<0.001
BMI (kg/m ²)	0.18	0.05	0.30	0.007

Correlation analysis found that both genders had lower HGS as their age increased ($r = -0.310$, $p < 0.001$), i.e., there was a gradual decline of HGS in both males and females as they got older. This change is attributable to the process of aging that results in alteration in muscle fiber composition (27) and a gradual decrease in the number of muscle fibers (28) causing reduced muscle strength. In addition, aging also reduces muscle building (29). It was also evident that the BMI of male and female participants decreased as they got older.

According to the standard HGS rating system of the Sports Authority of Thailand (16), most participants had very low HGS. This finding dif-

fers from a previous study which found that most elderly individuals had moderate HGS (16). This difference is probably due to the fact that the mean age of participants in this study was older than the previous study.

Correlation analysis found that BMI had a positive correlation with HGS ($r = 0.174$, $p < 0.001$). Among the male participants, all individuals in the normal and overweight groups had a significantly higher HGS than those in the underweight group ($p < 0.01$). Among the female participants, all individuals in the normal, overweight, and obese groups had a significantly higher HGS than those in the underweight group ($p < 0.05$). The results of this study in the context of nutritional effects on HGS were similar to previously published studies: lower BMI was correlated with lower HGS (29). A low BMI has been shown to be associated with lower body muscle and fat, which is directly associated with lower HGS (29).

Conclusion

Based on statistical analysis of the study results, conclusions can be drawn as follows:

- Males have significantly greater height, weight, and HGS than females ($p < 0.001$).
- As age increases, both males and females have lower HGS.
- Based on BMI classification, individuals who are normal weight or overweight have a significantly higher HGS than those who are underweight ($p < 0.01$).
- Male gender and higher BMI were positively correlated with higher HGS, while age was negatively correlated with HGS.

Acknowledgement

This study was supported by the National Research Council of Thailand. No.EC-54-14

Ethics

This research was approved by the Research Ethic Committee of Suranaree University of Technology, Nakhon Ratchasima, Thailand.

Conflicts of interest

None

References

1. Prasartkul P, editor. Situation of the Thai Elderly 2014. Bangkok; Amarin Printing & Publishing; 2016.
2. Danielewicz AL, Barbosa AR, Del Duca GF. Nutritional status, physical performance and functional capacity in an elderly population in southern Brazil. *Rev Assoc Med Bras* (1992). 2014;60:242-8.
3. Rantanen T, Volpato S, Ferrucci L, Heikkinen E, Fried LP, Guralnik JM. Handgrip strength and cause-specific and total mortality in older disabled women: exploring the mechanism. *J Am Geriatr Soc*. 2003;51:636-41.
4. Norman K, Schutz T, Kemps M, Josef Lubke H, Lochs H, Pirlich M. The Subjective Global Assessment reliably identifies malnutrition-related muscle dysfunction. *Clin Nutr*. 2005;24:143-50.
5. Matos LC, Tavares MM, Amaral TF. Handgrip strength as a hospital admission nutritional risk screening method. *Eur J Clin Nutr*. 2007;61:1128-35.
6. Vaz M, Thangam S, Prabhu A, Shetty PS. Maximal voluntary contraction as a functional indicator of adult chronic undernutrition. *Br J Nutr*. 1996;76:9-15.
7. Rantanen T, Guralnik JM, Foley D, Masaki K, Leveille S, Curb JD, et al. Midlife handgrip strength as a predictor of old age disability. *JAMA*. 1999;281:558-60.
8. Taekema DG, Gussekloo J, Maier AB, Westendorp RG, de Craen AJ. Handgrip strength as a predictor of functional, psychological and social health. A prospective population-based study among the oldest old. *Age Ageing*. 2010;39:331-7.
9. Cesari M, Onder G, Russo A, Zamboni V, Barillaro C, Ferrucci L, et al. Comorbidity and physical function: results from the aging and longevity study in the Sirente geographic area (ilSIRENTE study). *Gerontology*. 2006;52:24-32.
10. Park SW, Goodpaster BH, Strotmeyer ES, de Rekeneire N, Harris TB, Schwartz AV, et al. Decreased muscle strength and quality in older adults with type 2 diabetes: the health, aging, and body composition study. *Diabetes*. 2006;55:1813-8.
11. Silventoinen K, Magnusson PK, Tynelius P, Batty GD, Rasmussen F. Association of body size and muscle strength with incidence of coronary heart disease and cerebrovascular diseases: a population-based cohort study of one million Swedish men. *Int J Epidemiol*. 2009;38:110-8.
12. Syddall H, Cooper C, Martin F, Briggs R, Aihie Sayer A. Is grip strength a useful single marker of frailty? *Age and ageing*. 2003;32:650-6.
13. Cawthon PM, Fox KM, Gandra SR, Delmonico MJ, Chiou CF, Anthony MS, et al. Do muscle mass, muscle density, strength, and physical function similarly influence risk of hospitalization in older adults? *J Am Geriatr Soc*. 2009;57:1411-9.
14. Kerr A, Syddall HE, Cooper C, Turner GF, Briggs RS, Sayer AA. Does admission grip strength predict length of stay in hospitalised older patients? *Age and ageing*. 2006;35:82-4.
15. Sasaki H, Kasagi F, Yamada M, Fujita S. Grip strength predicts cause-specific mortality in middle-aged and elderly persons. *Am J Med*. 2007;120:337-42.
16. Aekplakorn W, editor. National Health Examination Survey, NHES V; 2014, Thailand. Bangkok: Graphic and Design; 2016.
17. Yamane T. Statistics, An Introductory Analysis. 3rd ed. New York: Harper and Row; 1973.
18. Chilima DM, Ismail SJ. Anthropometric characteristics of older people in rural Malawi. *Eur J Clin Nutr*. 1998; 52:643-9.
19. World Health Organization.int (homepage on the internet). Geneva: BMI classification (updated 2018 June 6; cited 2018 June 7). Available from: <http://www.who.int>
20. Liu W, Unick J, Galik E, Resnick B. Barthel Index of activities of daily living: item response theory analysis of ratings for long-term care residents. *Nurs Res*. 2015;64:88-99. doi: 10.1097/NNR.0000000000000072.
21. American Society of Hand T. Clinical assessment recommendations. Chicago, Ill: second edition published in 1992.

22. Skelton DA, Greig CA, Davies JM, Young A. Strength, power and related functional ability of healthy people aged 65-89 years. *Age and ageing*. 1994;23:371-7.
23. Hu H, Li Z, Yan J, Wang X, Xiao H, Duan J, et al. Anthropometric measurement of the Chinese elderly living in the Beijing area. *Int J Ind Ergon*. 2007;37:303-11.
24. Coqueiro RdS, Barbosa AR, Borgatto AF. Anthropometric measurements in the elderly of Havana, Cuba: Age and sex differences. *Nutrition*. 2009;25:33-9.
25. Nurul Shahida MS, Siti Zawiah MD, Case K. The relationship between anthropometry and handgrip strength among elderly Malaysians. *Int J Ind Ergon*. 2015;50:17-25.
26. Perissinotto EI, Pisent C, Sergi G, Grigoletto F; ILSA Working Group (Italian Longitudinal Study on Ageing) Anthropometric measurements in the elderly: age and gender differences. *Br J Nutr*. 2002;87:177-86.
27. Lexell J. Human aging, muscle mass, and fiber type composition. *J Gerontol A Biol Sci Med Sci*. 1995;50 Spec No:11-6.
28. Grimby G. Muscle performance and structure in the elderly as studied cross-sectionally and longitudinally. *J Gerontol A Biol Sci Med Sci*. 1995;50 Spec No:17-22.
29. Chilima DM, Ismail SJ. Nutrition and handgrip strength of older adults in rural Malawi. *Public Health Nutr*. 2001;4:11-7.

แรงบีบมือของผู้สูงอายุไทยที่อาศัยอยู่ในชุมชนในจังหวัดนครราชสีมา

จิตรวดี หอพิบูลสุข,¹ วรณนิศา นุชคุ้ม² และ พรศิริ จงกล²

¹สาขาวิชาอายุรศาสตร์ สำนักรักษาแพทยศาสตร์, ²สาขาวิชาวิศวกรรมอุตสาหการ สำนักรักษาวิศวกรรมศาสตร์ มหาวิทยาลัยเทคโนโลยีสุรนารี

วัตถุประสงค์ เพื่อศึกษาแรงบีบมือและปัจจัยต่าง ๆ ที่เกี่ยวข้องกับแรงบีบมือของผู้สูงอายุไทยที่อาศัยอยู่ในชุมชนในจังหวัดนครราชสีมา

วิธีการ การศึกษาแบบภาคตัดขวางของผู้สูงอายุไทยจำนวน 491 คน ที่อาศัยอยู่ในชุมชนในจังหวัดนครราชสีมา โดยศึกษาสัดส่วนของร่างกาย ความสามารถในการดำเนินชีวิตประจำวันดัชนีบาร์เซล ประเมินแรงบีบมือข้างที่ถนัดโดยใช้เครื่องมือมาตรฐาน

ผลการศึกษา ผู้สูงอายุที่เข้าร่วมการศึกษามีทั้งหมด 491 คน มีอายุเฉลี่ย 69.15 ± 6.86 ปี เมื่อเปรียบเทียบแรงบีบมือระหว่างเพศชายและหญิงพบว่าค่าเฉลี่ยแรงบีบมือเพศชายมากกว่าเพศหญิงอย่างมีนัยสำคัญทางสถิติ (24.93 ± 7.45 และ 16.17 ± 4.82 , $p < 0.001$) และยังพบว่าทั้งสองเพศมีแรงบีบมือที่ลดลงตามอายุที่มากขึ้น ($r = -0.310$, $p < 0.01$) เมื่อจัดกลุ่มผู้สูงอายุตามดัชนีมวลกายพบว่ากลุ่มที่มีดัชนีมวลกายปกติหรือเกินเกณฑ์จะมีแรงบีบมือมากกว่ากลุ่มที่มีดัชนีมวลกายต่ำกว่ามาตรฐาน ($p < 0.001$).

สรุป ผู้สูงอายุทั้งเพศหญิงและชายจะมีแรงบีบมือลดลงเมื่ออายุมากขึ้น ผู้สูงอายุเพศชายจะมีแรงบีบมือมากกว่าเพศหญิง กลุ่มผู้สูงอายุที่มีดัชนีมวลกายปกติหรือเกินเกณฑ์จะมีแรงบีบมือมากกว่ากลุ่มที่มีดัชนีมวลกายต่ำกว่าปกติ **เชียงใหม่เวชสาร 2562;58(1):15-22.**

คำสำคัญ: HGS, Thai elderly, BMI, Community