Prevalence of Anemia and Its Association with Handgrip Strength in Indonesian Elderly Population: A Cross-Sectional Study Using Indonesian Family Life Survey Data Year 2014-2015

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Abstract

Aim

This study aimed to elucidate the prevalence of anemia in Indonesian elderly population aged ≥60 years old and to analyze its association with handgrip strength in the elderly.

Method

This was a cross-sectional study using data from Indonesian Family Life Survey-5 (IFLS-5). All participants aged ≥60 years old were included in this study. Exclusion criteria were: (1) respondents who refused to take health measurements (hemoglobin level, handgrip strength, weight, stature, and waist circumference); (2) respondents with incomplete or missing data; (3) respondents with history of stroke; and (4) respondents with history of pain, swelling, inflammation, injury, and surgery on one or both hands within the last 6 months. The dependent variable for this study was handgrip strength. The independent variables were hemoglobin level, gender, age, body mass index (BMI), waist circumference, smoking history, comorbidities, and current use of drug therapies. Statistical analyses included correlation, bivariable, and multivariable analyses.

Result

A total of 3192 individuals were selected for analysis. Overall, 38.8% of participants aged ≥60 years had anemia based on definition of anemia by WHO. There was a positive correlation between hemoglobin level and handgrip strength in Indonesian elderly population (r: 0.349; p value: 0.000). Multivariable analysis showed that anemia was significantly associated with weak handgrip strength (OR: 1.557; 95% CI: 1.314-1.846; p value: 0.000). This association was stronger for males and elderly aged ≥80 years old.

Conclusion

Based on the results, anemia was associated with weak handgrip strength in Indonesian elderly population and it is more pronounced in males and elderly aged ≥80 years old.

Introduction

Indonesia as the fourth most populous country is experiencing an increase in life expectancy.[1,2] While this is a well-received improvement for Indonesia, there are several concerning consequences that may impact the country negatively if not promptly solved. One of the these is the growth of Indonesian elderly population.[3] By the year 2050, it is predicted that the Indonesian aging population will be around 25%

(around 74 million) of the total Indonesian population.[4] Thus, Indonesia must be ready to tackle common medical issues related to elderly population such as anemia and frailty.[5,6]

A systematic review conducted by Gaskell et al. showed that weighted mean anemia prevalence was 17% (3–50%) in the elderly.[5] Anemia is universally recognized as an important risk factor for numerous adverse clinical outcomes in the elderly such as mortality, cardiovascular disease, dementia, and cognitive impairment.[7–10] Another clinical significance of anemia is its association with reduction of handgrip strength and other functional outcomes.[11–16] It is speculated that anemia causes diminished muscular oxygenation and reduction of muscle strength through impairment of oxygen delivery.[12,17] The decline of exercise tolerance in anemia may then further reduce muscle mass through disuse.[18] Nevertheless, many of these studies were conducted on Caucasian populations, which have been shown to have different body composition from those of Asian population.[19,20] For examples, Asian population has smaller body size, higher adiposity proportion, different socioeconomic backgrounds, and palm length.[19–22] These differences were shown to impact many medical outcomes.[21,23] Furthermore, there is a relative paucity of data regarding anemia prevalence in Asian countries, especially Southeast Asia.

Hence, we aimed to elucidate the prevalence of anemia in the Indonesian elderly population and to analyze its association with handgrip strength in the elderly. To the best of our knowledge, there is currently no study that assess anemia prevalence of Indonesian elderly population in multiple provinces and analyze its association with handgrip muscle strength. We are confident that this study will contribute to epidemiological policy-making in Asia and contribute to the relatively scarce literatures on geriatric medicine in Asia.

Research Questions

There are several research questions explored in this study:

1. What is the prevalence of anemia in Indonesian participants aged ≥60 years old?
2. Are there any differences in the prevalence of anemia based on sex and age?
3. Do participants with anemia have weaker handgrip strength?
4. What are the factors associated with weak handgrip strength?

Method

Setting

The Indonesian Family Life Survey (IFLS) is longitudinal large-scale survey based on samples of households living in 13 provinces from three different islands in Indonesia which represented 83% of Indonesian population.[24] There are 4 provinces from Sumatra Island (North Sumatra, West Sumatra, South Sumatra, and Lampung) and 5 provinces from Java Island (DKI Jakarta, West Java, Central Java, DI Yogyakarta, East Java). Furthermore, the provinces also included Bali, West Nusa Tenggara, South

Kalimantan, and South Sulawesi. The other 14 provinces were excluded due to cost-effectiveness reasons. IFLS is currently the only multipurpose population-based survey with large sample size in Indonesia that measured health outcomes.

In IFLS, a multistage stratified sampling design was used, where initially, the sampling was stratified on provinces.[24] Subsequently, the sampling was conducted randomly within the provinces.

According to IFLS documentation, currently, there are a total of five waves of IFLS conducted, as follows[24]:

- The first wave (IFLS1) in 1993;
- The second wave (IFLS2) in 1997;
- The third wave (IFLS3) in 2000;
- The fourth wave (IFLS4) in late 2007 and early 2008;
- The fifth wave (IFLS5) in late 2014 and early 2015.

Statement of Ethics

The procedures of IFLS surveys were reviewed and approved by institutional review boards (IRBs) in both United States and Indonesia.[24] In United States, the IRBs responsible for ethical review of IFLS was Research and Development (RAND) corporation, a nonprofit think tank. Meanwhile, in Indonesia, the IFLS-5 study was approved by IRBs at Universitas Gadjah Mada (UGM).

The protocol approval number given by RAND's Human Subjects Protection Committee (RAND's IRB) for IFLS-5 was s0064-06-01-CR01.

Funding

The funding for IFLS5 was provided by several institutions.[24] Those institutions are:

1. National Institute on Aging (NIA), grant 2R01 AG026676-05
2. National Institute for Child Health and Human Development (NICHD), grant 2R01 HD050764-05A1
3. Department of Foreign Affairs and Trade (DFAT), Government of Australia
4. Grants from the World Bank, Indonesia, and GRM International

Data Availability

The datasets supporting the conclusions of this article are available from RAND website: https://www.rand.org/well-being/social-and-behavioral-policy/data/FLS/IFLS.html.

Study Design

This study was a multicenter, non-interventional, cross-sectional study using data from IFLS5 that was conducted in late 2014 and early 2015 at 13 provinces in Indonesia. Despite IFLS consisted of five waves, only the most recent wave, the fifth IFLS (IFLS5) was used for this study.

The dependent variable for this study was handgrip strength. The independent variables were hemoglobin level, gender, age, body mass index (BMI), waist circumference, smoking history, comorbidities, and current use of drug therapies.

The inclusion criteria used in this study was respondents aged ≥60 years old as in Indonesia, the elderly is defined by age 60 years and above.[25] Exclusion criteria were: (1) respondents who refused to take health measurements (hemoglobin level, handgrip strength, weight, stature, and waist circumference); (2) respondents with incomplete or missing data; (3) respondents with history of stroke; and (4) respondents with a history of pain, swelling, inflammation, injury, and surgery on one or both hands within the last 6 months.

Variable Classifications and Measurements

Hemoglobin Level

Hemoglobin test was performed using capillary blood drawn from a finger prick. The measurement was performed using a Hemocue handheld meter (model Hb201+) together with its respective HB201 microcuvettes. The finger sticks lancets manufactured by Hospital and Home Care were used. Meanwhile, the dried blood spot cards used were Whatman® 903 Protein Saver Cards containing five half-inch circles with each circle capable of holding 75 to 80 μL of sample.[26]

Based on WHO standard, male and female participants with Hb less than 13 g/dL and 12 g/dL, respectively, were defined as anemic.[27]

Handgrip Strength

Handgrip strength on each hand was measured twice using a Baseline Smedley Spring type dynamometer. The dynamometer was calibrated daily.

Trained personals instructed the study participants to hold and squeeze the handle of the dynamometer as firmly as they could. The measurement begins with the dominant hand and continues with alternating hand, with a resting period in between measurements.

The value for handgrip strength used for this study was the average of both left and right hands, each measured twice. Subjects were classified as weak if the handgrip strength <28 kg for men and <18 kg for women based on classification from Asian Working Group for Sarcopenia (AWGS) 2019.[19]

Confounders

Confounders included in this study were age, sex, BMI, waist circumference, history of smoking, comorbidities, history of taking anemia medicine, history of taking hypertension medicine, history of taking diabetes medicine, and history of taking cholesterol medicine.

The stature of subjects was recorded to the nearest millimeter using a Seca plastic height board (model 213). Meanwhile, weights of subjects were measured using Camry model EB1003 scale to the nearest tenth of a kilogram. Subsequently, body mass index (BMI) was calculated as weight in kg divided by stature in meter square. The BMI was classified based on Western Pacific Region of World Health Organization criteria which are: (1) <18.5 kg/m^2 as underweight; (2) 18.5 to 22.9 kg/m^2 as normal weight; (3) 23.0 to 24.9 kg/m^2 as overweight; and (4) ≥25 kg/m^2 as obese.[28]

Waist circumference was based on cut-offs of ≥80 cm for women and ≥90 cm for men.

The comorbidities were heart disease, diabetes, hypercholesterolemia, hypertension, kidney disease, and tuberculosis. Comorbidities were assessed using the question “Have a doctor/paramedic/nurse/midwife ever told you had…. (Comorbidities mention above)”.

This study also investigated whether the participant had been taking drug therapies for anemia, hypertension, diabetes, and hypercholesterolemia. Participants were categorized into yes and no groups based on whether they take the medicine or not.

Statistical Analysis

All statistical analyses were performed using SPSS Statistical software version 21.0 (IBM Corp, Armonk, NY, USA) with statistical significance defined as $p < 0.05$.

In this study, categorical variables reported as percentages were used for characteristics of our study population. Prevalence of anemia and weak handgrip strength were calculated as percentages. Sex-specific and age-specific anemia prevalence were also calculated. Differences in prevalence of anemia between participants aged ≥80 years old with those aged <80 years old were assessed using Chi-square (χ^2) test.

Correlation analysis was conducted using Pearson’s correlation test for data with normal distribution. If the data has non-parametric distribution, Spearman correlation was used instead. Normality of data was assessed using Kolmogorov–Smirnov test and Shapiro-Wilk test.

Logistic regression was conducted for bivariable and multivariable analysis of risk factors associated with weak handgrip strength. Subsequently, Hosmer and Lemeshow test was used to determine goodness of fit for the multivariable model. Multicollinearity test was also conducted with multicollinearity defined as variable inflation factor (VIF) >5. The multivariable analysis in this study employed a backward elimination model-building process.

Subgroup analysis was then conducted to explore the association between anemia and weak handgrip strength based on gender and age (60-69 years, 70-79 years, and ≥ 80 years)

Result

Eligible Participants

In total, 52587 unique individuals were obtained after combining from multiple datasets of IFLS5. Of these, 3742 participants aged ≥60 years old were selected. Subsequently, 86 individuals without hemoglobin measurement and 172 individuals with a history of pain, swelling, inflammation, injury, and surgery on one or both hands within the last 6 months were excluded. Another 174 individuals were excluded due to missing data in handgrip, waist circumference, and weight or stature measurements. Additionally, 111 individuals with stroke were excluded. Finally, 7 individuals that did not know whether they have comorbidities were excluded. Hence, a total of 3192 individuals were selected for analysis (Figure 1).

Characteristics of the Study Participants

Characteristics of participants are summarized in **Table 1**.

Table 1. Characteristics of the study participants.

		All Gender (n: 3192)	Males (n: 1518)	Females (n: 1674)
Variables	Category	n (%)	n (%)	n (%)
Anemia	Yes	1238 (38.8)	593 (39.1)	645 (38.5)
	No	1954 (61.2)	925 (60.9)	1029 (61.5)
Handgrip strength	Weak strength	2192 (68.7)	1035 (68.2)	1157 (69.1)
	Normal strength	1000 (31.3)	483 (31.8)	517 (30.9)
Age	≥ 80 years	279 (8.7)	141 (9.3)	138 (8.2)
	70-79 years	954 (29.9)	443 (29.2)	511 (30.5)
	60-69 years	1959 (61.4)	934 (61.5)	1025 (61.2)
BMI	Obese	732 (22.9)	232 (15.3)	500 (29.9)
	Overweight	478 (15)	212 (14)	266 (15.9)
	Underweight	638 (20)	333 (21.9)	305 (18.2)
	Normal	1344 (42.1)	741 (48.8)	603 (36)
Waist circumference	High	1340 (42)	294 (19.4)	1046 (62.5)
	Normal	1852 (58)	1224 (80.6)	628 (37.5)
Smoking history	Yes	1432 (44.9)	1213 (79.9)	219 (13.1)
	No	1760 (55.1)	305 (20.1)	1455 (86.9)
Heart disease	Yes	133 (4.2)	61 (4)	72 (4.3)
	No	3059 (95.8)	1457 (96)	1602 (95.7)
Hypertension	Yes	911 (28.5)	350 (23.1)	561 (33.5)
	No	2281 (71.5)	1168 (76.9)	1113 (66.5)
Hypercholesterolemia	Yes	196 (6.1)	76 (5)	120 (7.2)
	No	2996 (93.9)	1442 (95)	1554 (92.8)
Diabetes	Yes	173 (5.4)	88 (5.8)	85 (5.1)
	No	3019 (94.6)	1430 (94.2)	1589 (94.9)
Kidney Disease	Yes	48 (1.5)	29 (1.9)	19 (1.1)
	No	3144 (98.5)	1489 (98.1)	1655 (98.9)
Tuberculosis	Yes	46 (1.4)	31 (2)	15 (0.9)
	No	3146 (98.6)	1487 (98)	1659 (99.1)

Taking anemia medicine	Yes	50 (1.6)	22 (1.4)	28 (1.7)
	No	3142 (98.4)	1496 (98.6)	1646 (98.3)
Taking hypertension medicine	Yes	270 (8.5)	106 (7)	164 (9.8)
	No	2922 (91.5)	1412 (93)	1510 (90.2)
Taking Diabetes Medicine	Yes	91 (2.9)	46 (3)	45 (2.7)
	No	3101 (97.1)	1472 (97)	1629 (97.3)
Taking cholesterol medicine	Yes	61 (1.9)	19 (1.3)	42 (2.5)
	No	3131 (98.1)	1499 (98.7)	1632 (97.5)

Prevalence of Anemia

The prevalence of anemia can be seen in **Table 2**. Overall, 38.8% of participants aged ≥60 years had anemia based on the definition of anemia by WHO.[27] When adjusted by age, the prevalence of anemia is lowest on age 60-64 (28.8%), but it slowly increases with age, resulting in participants aged ≥80 years old having the highest prevalence of anemia (56.3%). The differences in anemia prevalence between participants aged ≥80 years old and participants aged <80 years old were significant statistically (**Table 1. Supplementary**).

Table 2. Prevalence of Anemia Based on Age and Gender

Gender	Age					
	All Age (n: 3192)	60-64 (n: 1216)	65-69 (n: 743)	70-74 (n: 636)	75-79 (n: 318)	≥80 (n: 279)
All Gender	38,80%	31,50%	37,70%	41,50%	48,40%	56,30%
Male only	39,10%	28,80%	39,40%	42,30%	52,00%	59,60%
Female only	38,50%	33.9%	36,10%	40,80%	45,20%	52,90%

Prevalence of Weak Handgrip

The prevalence of weak handgrip can be seen on **Table 3**. Using handgrip criteria from Asian Working Group for Sarcopenia (AWGS), a total of 68.7% participants had weak handgrip.[19] The prevalence of weak handgrip also increased with age.

Table 3. Prevalence of Weak Handgrip Strength Based on Age and Gender

Gender	Age					
	All Age (n: 3192)	60-64 (n: 1216)	65-69 (n: 743)	70-74 (n: 636)	75-79 (n: 318)	≥80 (n: 279)
All Gender	68,70%	52,80%	67,20%	81.60%	87,70%	90,70%
Male only	68.20%	51.5%	65.6%	81.9%	90%	91.5%
Female only	69.10%	54%	68.6%	81.3%	85.7%	89.9%

Correlation Between Hemoglobin Level, Age, BMI, and Waist Circumference with Handgrip Strength

The variables of hemoglobin, age, BMI, and waist circumference were analysed for normality test using Kolmogrov-Smirnov test and Shapiro-Wilk test, which showed non-normal data distribution for all these variables (**Table 2. Supplementary**). Thus, spearman correlation was used for the correlation test. Based on correlations tests, hemoglobin was positively correlated with handgrip strength. Results of correlation tests can be seen on **Table 4, Figure 2, and Figure 3.**

Table 4. Correlation Test Results

Variables	All patient (n: 3192)		Male only (n: 1518)		Female only (n: 1674)		Age 60-79 only (n: 2913)		Age ≥80 only (n: 279)	
	Correlation Coefficient	P value	Correlation Coefficient	P value	Correlation Coefficient	P value	Correlation Coefficient	P value	Correlation Coefficient	P value
Hemoglobin level-handgrip strength	0.349	0.000	0.246	0.000	0.131	0.000	0.349	0.000	0.224	0.000
Age-handgrip strength	-0.319	0.000	-0.425	0.000	-0.383	0.000	-0.271	0.000	-0.104	0.084
BMI-handgrip strength	0.094	0.000	0.289	0.000	0.251	0.000	0.061	0.001	0.063	0.296
Waist circumference-handgrip strength	0.048	0.000	0.238	0.000	0.178	0.000	0.026	0.168	0.045	0.452

Bivariable Analysis and Multivariable Analysis

Bivariable and multivariable analysis are shown in **Table 5**. Hosmer and Lemeshow test to assess quality of the multivariable analysis models showed a p value of 0.424 (χ^2: 8.098 and degree of freedom: 8). Therefore, there is no statistically significant difference between observed handgrip strength status and expected handgrip status from the multivariable model, indicating well-calibrated model. Multicollinearity

test of the variables used for multivariable analysis showed no presence of multicollinearity. The multicollinearity test and complete regression parameters of the multivariable analysis can be seen on Table 3 Supplementary and Table 4 Supplementary.

We conducted subgroup analysis based on age (**Table 6**). Based on the analysis, the odds ratios for weak handgrip strength were highest in participants aged ≥ 80 years. Additionally, participants with male gender had higher odds ratios for weak handgrip strength

Table 5. Bivariable and Multivariable Analysis (n: 3192)

Variable	Category	Bivariable Analysis			Multivariable Analysis		
		Odds ratio	95% CI	p value	Adjusted Odds ratio	95% CI	p value
Anemia	Yes	1.904	1.621-2.236	0.000	1.557	1.314-1.846	0.000
	No	Reference			Reference		
Age	≥ 80 years	6.976	4.613-10.549	0.000	5.234	3.438-7.969	0.000
	70-79 years	3.667	3.022-4.451	0.000	3.152	2.584-3.843	0.000
	60-69 years	Reference			Reference		
Sex	Male	0.958	0.824-1.112	0.570	-	-	-
	Female	Reference			Reference		
BMI	Obese	0.547	0.454-0.660	0.000	0.696	0.570-0.850	0.000
	Overweight	0.750	0.602-0.934	0.000	0.861	0.684-1.085	0.204
	Low	2.134	1.681-2.710	0.000	1.827	1.424-2.345	0.000
	Normal	Reference			Reference		
Waist circumference	High	0.579	0.497-0.673	0.000	-	-	-
	Normal	Reference			Reference		
Smoking history	Yes	1.052	0.905-1.223	0.508	-	-	-
	No	Reference			Reference		
Hypertension	Yes	1.185	1.001-1.402	0.048	1.340	1.116-1.609	0.002
	No	Reference			Reference		
Hypercholesterolemia	Yes	0.562	0.419-0.752	0.000	0.764	0.557-1.046	0.093
	No	Reference			Reference		
Heart Disease	Yes	1.063	0.728-1.552	0.750	-	-	-
	No	Reference			Reference		
Diabetes	Yes	0.786	0.571-1.081	0.139	-	-	-
	No	Reference			Reference		
Kidney Disease	Yes	0.692	0.386-1.241	0.217	-	-	-
	No	Reference			Reference		

Tuberculosis	Yes No	1.653 Reference	0.817-3.344	0.162	- Reference	-	-
Take medicine for Anemia	Yes No	0.488 Reference	0.279-0.855	0.012	0.539 Reference	0.294-0.989	0.046
Take medicine for hypertension	Yes No	0.888 Reference	0.682-1.157	0.379	- Reference	-	-
Take medicine for diabetes	Yes No	0.759 Reference	0.493-1.168	0.209	- Reference	-	-
Take medicine for hypercholesterolemia	Yes No	0.749 Reference	0.444-1.265	0.280	- Reference	-	-

Table 6. Subgroup Analysis for Association Between Anemia and Weak Handgrip Strength Based on Age and Gender

Variable	Category	Odds ratio for Weak Handgrip Strength	Lower 95% CI	Upper 95% CI	P value
Age*	60-69	1.569	1.286	1.914	0.000
	70-79	1.395	0.975	1.995	0.068
	≥ 80	2.662	1.143	6.203	0.023
Gender^	Male	1.826	1.418	2.352	0.000
	Female	1.336	1.059	1.684	0.014

*Adjusted for sex, BMI, smoking history, waist circumference, diabetes, heart disease, hypercholesterolemia, hypertension, kidney disease, tuberculosis, take medicine for anemia, take medicine for hypertension, take medicine for diabetes, take medicine for hypercholesterolemia.

^ Adjusted for age, BMI, smoking history, waist circumference, diabetes, heart disease, hypercholesterolemia, hypertension, kidney disease, tuberculosis, take medicine for anemia, take medicine for hypertension, take medicine for diabetes, take medicine for hypercholesterolemia.

Discussion

Prevalence of Anemia in Indonesian Elderly

Anemia is often perceived as a benign condition due to aging process. Recently, this paradigm is challenged by studies showing that even mild anemia is a risk factor for adverse clinical outcomes in the elderly.[7–10]

This current study is the first Indonesian study with large sample that assesses the prevalence of anemia in the elderly. We observed that 38.8% of participants aged ≥60 years had anemia based on the definition of anemia by WHO (less than 12g/dL in women and less than 13 g/d in men). This is similar to the study by Hidayat et al. using 118 elderly participants living in nursing home.[29] According to a systematic review by Gaskell et al. which used 45 studies, the mean prevalence of anemia in older adults was 17% (3-50%).[5] Therefore, our results confirm that anemia is common in Indonesian elderly population and is within the range of the systematic review by Gaskell et al.[5] Furthermore, the anemia prevalence is similar to the prevalence of Malaysia, a neighbouring country that has similar ethnicities, with anemia prevalence of 35.3%.[30] Other studies on north-eastern Thailand, Philippines, and India showed anemia prevalence of 48%, 21.6%, and 68.7% respectively in the elderly.[31–33] However, Indonesia and all of these countries are in contrast with Singapore and Taiwan that had a lower anemia prevalence of 15.2% and 18.8% respectively.[34,35] The difference in prevalence between countries may be caused by heterogeneity in living conditions, elderly healthcare, health problems, and socioeconomic factors.

The age-associated increase of anemia in our study appears to be more pronounced in males than females. By the age of ≥65 years old, male have higher prevalence of anemia than females in our study. This observation is similar with data from Third National Health and Nutrition Examination Survey (NHANES III) from USA.[36] Other studies also observe this phenomenon.[5,37–40] The difference is that in the data by NHANES III, anemia became more common in males starting from age 75 while the anemia in our study started to become more common from age 65 years old.

We believe that the prevalence of anemia in Indonesian elderly may be indirectly caused by economic status and poverty since a significant number of Indonesians are living below poverty line. Poverty may impact the ability to access necessary animal-based food which contain iron to maintain hemoglobin. Data from NHANES III shown that around one third of anemic elderly had deficiencies in iron, folate, and cobalamin.[36,41] Additionally, a study specific for Indonesian elderly in East Java found that anemia in elderly is related to lower consumption of folic acid and higher consumption of coffee and tea due to the role of tannins as iron absorption inhibitor.[42] Other possible causes of anemia in the elderly include chronic kidney disease (CKD), chronic inflammation, and myelodysplastic syndrome.[41] Unfortunately, the datasets we obtained for this study did not have kidney function, marker of inflammations, and bone marrow examinations which made analyses of these causes impossible. Furthermore, there are currently no published studies in Indonesia on elderly Indonesian population that analyze the role of CKD, chronic inflammation, and myelodysplastic syndrome in anemia.

Prevalence of Weak Handgrip in Indonesian Elderly

Using criteria from AWGS 2019 that was based from 8 Asian cohorts aged ≥65 years, we observed that a total of 68.7% participants in our study had weak handgrip.[19,43] A study by Franks et al. using samples of individuals aged ≥ 50 years from six low- and middle-income countries showed weak handgrip prevalence of 47.4%.[44] Meanwhile, a study by Gi et al. in Korea showed a weak handgrip prevalence of

12.5%.[45] However, it should be noted that these studies differ in weak handgrip strength definitions, economic income, and racial population.

A recent study conducted in our institution using 164 elderly patients showed a weak handgrip prevalence of 67.1%.[46] However, despite a similar prevalence of weak handgrip with this study, it may not be comparable since the study used Jamar hydraulic dynamometer.[46] Here, we used Smedley spring type dynamometer for handgrip measurement which is the commonest used device in Asia for measuring handgrip strength.[47] The second commonest used device is Jamar hydraulic dynamometer.[47] According to AWGS 2019, the handgrip measurement from Jamar hydraulic dynamometer may be higher when compared with Smedley spring type dynamometer.[19] Thus, using different dynamometer may impact the prevalence of weak handgrip strength in a study, however, there is currently no available specific cutoffs made for these dynamometers.[19]

Factors Associated with Weak Handgrip Strength

Anemia causes a reduction in oxygen carrying capacity of the blood to organs, including to muscle tissue.[12,17] This impairment of oxygen delivery can result in decreased aerobic capacity, decreased physical strength, sarcopenia, and further reduce the already declined physiologic reserve in the elderly.[12,13,17,48] Additionally, both muscle strength and muscle mass appeared to be lower in anemic elderly.[12,14,49] However, it is believed that there are still unknown pathophysiological processes of anemia in the elderly. Further studies to elucidate the complete mechanisms of how anemia affects the elderly should be conducted.

The correlation tests in this study showed a positive correlation between hemoglobin level and handgrip strength in Indonesian elderly population which is consistent with other studies.[12,15,16,45,50,51] Studies on elderly population of >90 years old also demonstrated association between anemia with handgrip strength.[52,53] Similarly, we also observed that the association of anemia with weak handgrip was more pronounced in the oldest old group and in male group. Other studies have also shown the role of anemia in other medical outcomes such as cognitive declines and mortality.[10,18,54,55] Thus, anemia is clinically important in elderly due to poor medical outcomes associated with it. Further supporting this is the data showing that even low hemoglobin level in normal range cause higher risk of frailty.[56]

Based on this, it may be considered that the oldest old group should be screened for anemia and given prompt treatment. We observe that participants taking medicine had low odds ratios for weak handgrip, however, the 95% CI was very wide and further information of the type of anemia medicine and the dose were unavailable. Further studies to analyze how difference anemia medicine and dosages affect the elderly should be conducted.

Another important finding in this study is that the association of anemia with weak handgrip was more pronounced in the oldest old group and in male group. Nevertheless, despite these significant findings, it is very difficult to directly declare that anemia is a causal risk factor for weak handgrip due to

observational nature of this study and the possibility of anemia being a marker for other medical conditions. For examples, anemia is closely related to chronic inflammation which is observed in sarcopenia, hence, may indicate a bidirectional relationship between anemia and sarcopenia.[57–59]

Our study also found that hypertension, BMI, and age were risk factors for weak handgrip strength. The role of hypertension in handgrip strength and sarcopenia is currently unclear in some studies.[60,61] However, a recent systematic review and meta-analysis in 2020 conducted by Bai et al. showed that there was no association between hypertension and handgrip strength, albeit with very high heterogeniety.[62] The high heterogeneity may be caused by studies from different countries and lack of stratification from sex and age.[62] Excessive BMI in this study was protective against weak handgrip strength, but caution should be given when interpreting this as some elderly may have high BMI but loss of muscle, termed sarcopenic obesity.[63]

Study Limitations

Despite bridging the scientific gap of anemia and handgrip strength in the Indonesian elderly, the current study has several limitations. First, this study is a cross-sectional study which is unable to elucidate causal relationship between the variables and weak handgrip. Secondly, this study did not analyze the impact of dietary factors among the subjects on anemia. The type of anemia also could not be identified because of the insufficient laboratory and lack of nutritional status data. Finally, while the handgrip criteria from AWGS 2019 used normative handgrip data from Asian countries, we believe that using normative handgrip data specific for the Indonesian elderly population which is currently unavailable should be more appropriate.

Recommendations for Indonesia

1. We recommend future studies that analyse dietary intake of Indonesian elderly population to be conducted
2. We recommend studies that assess the prevalence of anemia in elderly based on etiologies to be conducted
3. We recommend a study to develop normative handgrip data for Indonesian population to be conducted
4. We recommend both short-term and long-term policies to be made by the Indonesian government to support health of elderly population

Conclusion

The prevalence of anemia in the Indonesian elderly population was 38.8%. Prevalence of anemia was affected by age and sex. Furthermore, anemia was significantly associated with weak handgrip strength in Indonesian elderly population. This association was stronger for males and elderly aged ≥80 years old.

Abbreviations

IFLS – Indonesian Family life Survey

IRBs – institutional review boards

RAND – Research and Development

UGM – University of Gadjah Mada

CKD – chronic kidney disease

NIA - National Institute on Aging

NICHD - National Institute for Child Health and Human Development

DFAT - Department of Foreign Affairs and Trade

BMI - Body Mass Index

WHO - World Health Organization

AWGS - Asian Working Group for Sarcopenia

NY - New York

USA - United States of America

SPSS - Statistical Product and Service Solutions

WC - Waist Circumference

Hb - Hemoglobin

OR - Odds Ratio

CI - Confidence Interval

NHANES - National Health and Nutrition Examination Survey

Declarations

Author Contributions

Noorwati Sutandyo, Ikhwan Rinaldi, Nina Kemala Sari, and Kevin Winston wrote the main manuscript text. Kevin Winston prepared all tables and figures. All authors reviewed the manuscript.

Availability of Data

The datasets used and/or analyzed during the current study are available from RAND website.

Conflict of Interest

The authors declare that they have no competing interests.

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References

1. Bongaarts J. Human population growth and the demographic transition. *Philos Trans R Soc B Biol Sci*. 2009;364(1532):2985–2990. doi:10.1098/rstb.2009.0137
2. Mboi N, Murty Surbakti I, Trihandini I, et al. On the road to universal health care in Indonesia, 1990–2016: a systematic analysis for the Global Burden of Disease Study 2016. *Lancet Lond Engl*. 2018;392(10147):581–591. doi:10.1016/S0140-6736(18)30595-6
3. Jones GW. The 2010–2035 Indonesian population projection: understanding the causes, consequences and policy options for population and development. Published online 2015. https://indonesia.unfpa.org/sites/default/files/pub-pdf/Policy_brief_on_The_2010_%E2%80%93_2035_Indonesian_Population_Projection.pdf
4. Hastuti, Arfyanto H, Rahman MA, Toyamah N, Murniati S. The Situation of the Elderly in Indonesia and Access to Social Protection Programs: Secondary Data Analysis | The SMERU Research Institute. *SMERU Res Inst*. Published online 2020. Accessed October 21, 2021. https://smeru.or.id/en/content/situation-elderly-indonesia-and-access-social-protection-programs-secondary-data-analysis
5. Gaskell H, Derry S, Andrew Moore R, McQuay HJ. Prevalence of anaemia in older persons: systematic review. *BMC Geriatr*. 2008;8:1. doi:10.1186/1471-2318-8-1
6. Ofori-Asenso R, Chin KL, Mazidi M, et al. Global Incidence of Frailty and Prefrailty Among Community-Dwelling Older Adults: A Systematic Review and Meta-analysis. *JAMA Netw Open*. 2019;2(8):e198398. doi:10.1001/jamanetworkopen.2019.8398
7. Culleton BF, Manns BJ, Zhang J, Tonelli M, Klarenbach S, Hemmelgarn BR. Impact of anemia on hospitalization and mortality in older adults. *Blood*. 2006;107(10):3841–3846. doi:10.1182/blood-2005-10-4308
8. Guinn NR, Cooter ML, Villalpando C, Weiskopf RB. Severe anemia associated with increased risk of death and myocardial ischemia in patients declining blood transfusion. *Transfusion (Paris)*. 2018;58(10):2290–2296. doi:10.1111/trf.14768

9. Denny SD, Kuchibhatla MN, Cohen HJ. Impact of Anemia on Mortality, Cognition, and Function in Community-Dwelling Elderly. *Am J Med*. 2006;119(4):327–334. doi:10.1016/j.amjmed.2005.08.027
10. Penninx BWJH, Pahor M, Woodman RC, Guralnik JM. Anemia in old age is associated with increased mortality and hospitalization. *J Gerontol A Biol Sci Med Sci*. 2006;61(5):474–479. doi:10.1093/gerona/61.5.474
11. Joosten E, Detroyer E, Milisen K. Effect of anaemia on hand grip strength, walking speed, functionality and 1 year mortality in older hospitalized patients. *BMC Geriatr*. 2016;16. doi:10.1186/s12877-016-0326-y
12. Penninx BWJH, Pahor M, Cesari M, et al. Anemia Is Associated with Disability and Decreased Physical Performance and Muscle Strength in the Elderly. *J Am Geriatr Soc*. 2004;52(5):719–724. doi:10.1111/j.1532-5415.2004.52208.x
13. Chaves PHM. Functional outcomes of anemia in older adults. *Semin Hematol*. 2008;45(4):255–260. doi:10.1053/j.seminhematol.2008.06.005
14. Moon JH, Kong MH, Kim HJ. Relationship between low muscle mass and anemia in Korean elderly men: Using the Korea National Health and Nutrition Examination Survey (KNHANES IV–V). *J Clin Gerontol Geriatr*. 2015;6(4):115–119. doi:10.1016/j.jcgg.2015.03.007
15. Hirani V, Naganathan V, Blyth F, et al. Low Hemoglobin Concentrations Are Associated With Sarcopenia, Physical Performance, and Disability in Older Australian Men in Cross-sectional and Longitudinal Analysis: The Concord Health and Ageing in Men Project. *J Gerontol A Biol Sci Med Sci*. 2016;71(12):1667–1675. doi:10.1093/gerona/glw055
16. Tseng SH, Lee WJ, Peng LN, Lin MH, Chen LK. Associations between hemoglobin levels and sarcopenia and its components: Results from the I-Lan longitudinal study. *Exp Gerontol*. 2021;150:111379. doi:10.1016/j.exger.2021.111379
17. Kim YJ, Han KD, Cho KH, Kim YH, Park YG. Anemia and health-related quality of life in South Korea: data from the Korean national health and nutrition examination survey 2008–2016. *BMC Public Health*. 2019;19:735. doi:10.1186/s12889-019-6930-y
18. Patel KV, Guralnik JM. Prognostic implications of anemia in older adults. *Haematologica*. 2009;94(1):1–2. doi:10.3324/haematol.2008.001289
19. Chen LK, Woo J, Assantachai P, et al. Asian Working Group for Sarcopenia: 2019 Consensus Update on Sarcopenia Diagnosis and Treatment. *J Am Med Dir Assoc*. 2020;21(3):300-307.e2. doi:10.1016/j.jamda.2019.12.012
20. Chen LK, Liu LK, Woo J, et al. Sarcopenia in Asia: Consensus Report of the Asian Working Group for Sarcopenia. *J Am Med Dir Assoc*. 2014;15(2):95–101. doi:10.1016/j.jamda.2013.11.025
21. Leow MKS. Characterization of the Asian Phenotype - An Emerging Paradigm with Clinicopathological and Human Research Implications. *Int J Med Sci*. 2017;14(7):639–647. doi:10.7150/ijms.18880
22. Wu SW, Wu SF, Liang HW, Wu ZT, Huang S. Measuring factors affecting grip strength in a Taiwan Chinese population and a comparison with consolidated norms. *Appl Ergon*. 2009;40(4):811–815.

doi:10.1016/j.apergo.2008.08.006

23. Narayan KMV, Kanaya AM. Why are South Asians prone to type 2 diabetes? A hypothesis based on underexplored pathways. *Diabetologia*. 2020;63(6):1103–1109. doi:10.1007/s00125-020-05132-5
24. Strauss J, Witoelar F, Sikoki B. The Fifth Wave of the Indonesia Family Life Survey: Overview and Field Report: Volume 1. Published online March 31, 2016. Accessed April 23, 2021. https://www.rand.org/pubs/working_papers/WR1143z1.html
25. Setiati S, Laksmi PW, Aryana IGPS, et al. Frailty state among Indonesian elderly: prevalence, associated factors, and frailty state transition. *BMC Geriatr*. 2019;19(1):182. doi:10.1186/s12877-019-1198-8
26. Whatman protein saver cards 903 Protein saver card (US), 100/pk pcr blood. Accessed November 3, 2021. https://www.sigmaaldrich.com/ID/en/product/aldrich/wha10534612
27. WHO. Haemoglobin Concentrations for the Diagnosis of Anaemia and Assessment of Severity. *Vitam Miner Nutr Inf Syst World Health Organ*. Published online 2011. Accessed April 13, 2021. https://www.who.int/vmnis/indicators/haemoglobin.pdf
28. WHO. The Asia-Pacific perspective: Redefining obesity and its treatment. *Int Assoc Study Obes WHO*. Published online 2000. Accessed April 15, 2021. https://apps.who.int/iris/bitstream/handle/10665/206936/0957708211_eng.pdf
29. Hidayat G, Kurnianda J, Pramantara IDP. ANEMIA AS RISK FACTOR OF HANDGRIP STRENGTH DECREASED ON ELDERLYIN YOGYAKARTAPROVINCE'S PANTI WERDHA. *Acta Interna J Intern Med*. 2011;1(1):10–14. doi:10.22146/acta
30. Yusof M, Awaluddin SM, Omar M, et al. Prevalence of Anaemia among the Elderly in Malaysia and Its Associated Factors: Does Ethnicity Matter? *J Environ Public Health*. 2018;2018:e1803025. doi:10.1155/2018/1803025
31. Deeruksa L, Sanchaisuriya K. Anemia in the Elderly in Northeastern Thailand: A Community-Based Study Investigating Prevalence, Contributing Factors, and Hematologic Features. *Acta Haematol*. 2017;138(2):96–102. doi:10.1159/000478771
32. Dungca JZ, Patron A, Liwanag M, Bermido CM, Balintona V, Yabut EV. Hematological Indices, Nutrient Intake and Health Status of Older Adults in Selected Suburban Filipino Community. Published online 2013. Accessed October 22, 2021. https://www.semanticscholar.org/paper/Hematological-Indices%2C-Nutrient-Intake-and-Health-Dungca-Patron/f2fbc714b0324381b7add878b490618fe35d6e4e
33. Pathania A, Haldar P, Kant S, Gupta SK, Pandav CS, Bachani D. Prevalence of anemia among elderly persons residing in old age homes in national capital territory, Delhi, India. *Indian J Public Health*. 2019;63(4):288–292. doi:10.4103/ijph.IJPH_412_18
34. Lee CT, Chen MZ, Yip CYC, Yap ES, Lee SY, Merchant RA. Prevalence of Anemia and Its Association with Frailty, Physical Function and Cognition in Community-Dwelling Older Adults: Findings from the HOPE Study. *J Nutr Health Aging*. 2021;25(5):679–687. doi:10.1007/s12603-021-1625-3

35. Wang JL, Shaw NS. Iron status of the Taiwanese elderly: the prevalence of iron deficiency and elevated iron stores. *Asia Pac J Clin Nutr*. 2005;14(3):278–284.
36. Guralnik JM, Eisenstaedt RS, Ferrucci L, Klein HG, Woodman RC. Prevalence of anemia in persons 65 years and older in the United States: evidence for a high rate of unexplained anemia. *Blood*. 2004;104(8):2263–2268. doi:10.1182/blood-2004-05-1812
37. Inelmen EM, D'Alessio M, Gatto MR, et al. Descriptive analysis of the prevalence of anemia in a randomly selected sample of elderly people living at home: some results of an Italian multicentric study. *Aging Milan Italy*. 1994;6(2):81–89. doi:10.1007/BF03324220
38. Chueh HW, Jung HL, Shim YJ, Choi HS, Han JY, on the behalf of the Red Blood Cell Disorder Working Party of The Korean Society of Hematology. High anemia prevalence in Korean older adults, an advent healthcare problem: 2007–2016 KNHANES. *BMC Geriatr*. 2020;20(1):509. doi:10.1186/s12877-020-01918-9
39. Skjelbakken T, Langbakk B, Dahl IMS, Løchen ML, Tromsø Study. Haemoglobin and anaemia in a gender perspective: the Tromsø Study. *Eur J Haematol*. 2005;74(5):381–388. doi:10.1111/j.1600-0609.2004.00392.x
40. Patel KV. Epidemiology of Anemia in Older Adults. *Semin Hematol*. 2008;45(4):210–217. doi:10.1053/j.seminhematol.2008.06.006
41. Pang WW, Schrier SL. Anemia in the elderly. *Curr Opin Hematol*. 2012;19(3):133–140. doi:10.1097/MOH.0b013e3283522471
42. Alamsyah PR, Andrias DR. HUBUNGAN KECUKUPAN ZAT GIZI DAN KONSUMSI MAKANAN PENGHAMBAT ZAT BESI DENGAN KEJADIAN ANEMIA PADA LANSIA. *Media Gizi Indones*. 2016;11(1):48–54. doi:10.20473/mgi.v11i1.48-54
43. Auyeung TW, Arai H, Chen LK, Woo J. Normative Data of Handgrip Strength in 26344 Older Adults - A Pooled Dataset from Eight Cohorts in Asia. *J Nutr Health Aging*. 2020;24(1):125–126. doi:10.1007/s12603-019-1287-6
44. Ashdown-Franks G, Stubbs B, Koyanagi A, et al. Handgrip strength and depression among 34,129 adults aged 50 years and older in six low- and middle-income countries. *J Affect Disord*. 2019;243:448–454. doi:10.1016/j.jad.2018.09.036
45. Gi Y mi, Jung B, Kim KW, Cho JH, Ha IH. Low handgrip strength is closely associated with anemia among adults: A cross-sectional study using Korea National Health and Nutrition Examination Survey (KNHANES). *PLoS ONE*. 2020;15(3). doi:10.1371/journal.pone.0218058
46. Umam FJ, Setiati S. Association between type II diabetes mellitus and hand grip strength in the elderly. *J Phys: Conf Ser*. 2018;1073:042035. doi:10.1088/1742-6596/1073/4/042035
47. Kim M, Shinkai S. Prevalence of muscle weakness based on different diagnostic criteria in community-dwelling older adults: A comparison of grip strength dynamometers. *Geriatr Gerontol Int*. 2017;17(11):2089–2095. doi:10.1111/ggi.13027
48. Halter J, Ouslander J, Tinetti M, et al. In: *HAZZARD'S GERIATRIC MEDICINE AND GERONTOLOGY*. 7th Edition. McGraw Hill Education;:1210.

49. Cesari M, Penninx BWJH, Lauretani F, et al. Hemoglobin levels and skeletal muscle: results from the InCHIANTI study. *J Gerontol A Biol Sci Med Sci*. 2004;59(3):249–254. doi:10.1093/gerona/59.3.m249
50. de Araújo Amaral C, Amaral TLM, Monteiro GTR, de Vasconcellos MTL, Portela MC. Factors associated with low handgrip strength in older people: data of the Study of Chronic Diseases (Edoc-I). *BMC Public Health*. 2020;20(1):395. doi:10.1186/s12889-020-08504-z
51. Santos PHS, Carmo ÉA, Carneiro JAO, Nery AA, Casotti CA. Handgrip strength: An effective screening instrument for anemia in the elderly women. *Public Health Nurs Boston Mass*. 2019;36(2):178–183. doi:10.1111/phn.12579
52. Payne CF, Davies JI, Gomez-Olive FX, et al. Cross-sectional relationship between haemoglobin concentration and measures of physical and cognitive function in an older rural South African population. *J Epidemiol Community Health*. 2018;72(9):796–802. doi:10.1136/jech-2018-210449
53. Thein M, Ershler WB, Artz AS, et al. Diminished quality of life and physical function in community-dwelling elderly with anemia. *Medicine (Baltimore)*. 2009;88(2):107–114. doi:10.1097/MD.0b013e31819d89d5
54. Qin T, Yan M, Fu Z, et al. Association between anemia and cognitive decline among Chinese middle-aged and elderly: evidence from the China health and retirement longitudinal study. *BMC Geriatr*. 2019;19(1):305. doi:10.1186/s12877-019-1308-7
55. Hong CH, Falvey C, Harris TB, et al. Anemia and risk of dementia in older adults. *Neurology*. 2013;81(6):528–533. doi:10.1212/WNL.0b013e31829e701d
56. Juárez-Cedillo T, Basurto-Acevedo L, Vega-García S, et al. Prevalence of anemia and its impact on the state of frailty in elderly people living in the community: SADEM study. *Ann Hematol*. 2014;93(12):2057–2062. doi:10.1007/s00277-014-2155-4
57. Wennberg AM, Ding M, Ebeling M, Hammar N, Modig K. Blood-Based Biomarkers and Long-term Risk of Frailty—Experience From the Swedish AMORIS Cohort. *J Gerontol Ser A*. 2021;76(9):1643–1652. doi:10.1093/gerona/glab137
58. Franceschi C, Bonafè M, Valensin S, et al. Inflamm-aging. An evolutionary perspective on immunosenescence. *Ann N Y Acad Sci*. 2000;908:244–254. doi:10.1111/j.1749-6632.2000.tb06651.x
59. Leng S, Chaves P, Koenig K, Walston J. Serum interleukin-6 and hemoglobin as physiological correlates in the geriatric syndrome of frailty: a pilot study. *J Am Geriatr Soc*. 2002;50(7):1268–1271. doi:10.1046/j.1532-5415.2002.50315.x
60. Gubelmann C, Vollenweider P, Marques-Vidal P. Association of grip strength with cardiovascular risk markers. *Eur J Prev Cardiol*. 2017;24(5):514–521. doi:10.1177/2047487316680695
61. Kawamoto R, Ninomiya D, Kasai Y, et al. Handgrip strength is associated with metabolic syndrome among middle-aged and elderly community-dwelling persons. *Clin Exp Hypertens*. 2016;38(2):245–251. doi:10.3109/10641963.2015.1081232

62. Bai T, Fang F, Li F, Ren Y, Hu J, Cao J. Sarcopenia is associated with hypertension in older adults: a systematic review and meta-analysis. *BMC Geriatr*. 2020;20(1):279. doi:10.1186/s12877-020-01672-y
63. Roh E, Choi KM. Health Consequences of Sarcopenic Obesity: A Narrative Review. *Front Endocrinol*. 2020;11:332. doi:10.3389/fendo.2020.00332

Figures

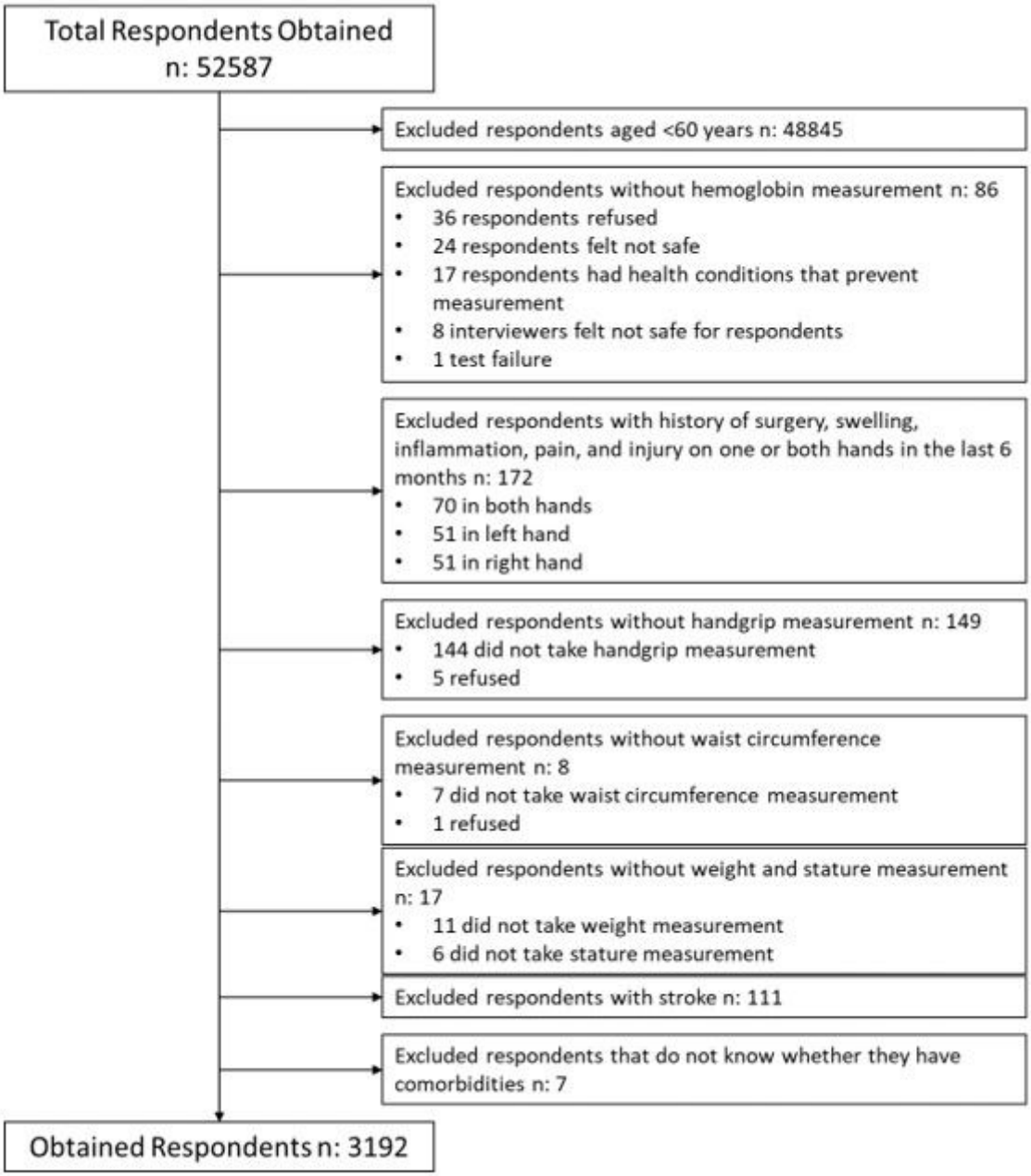

Figure 1

Flowchart of Participants Selection

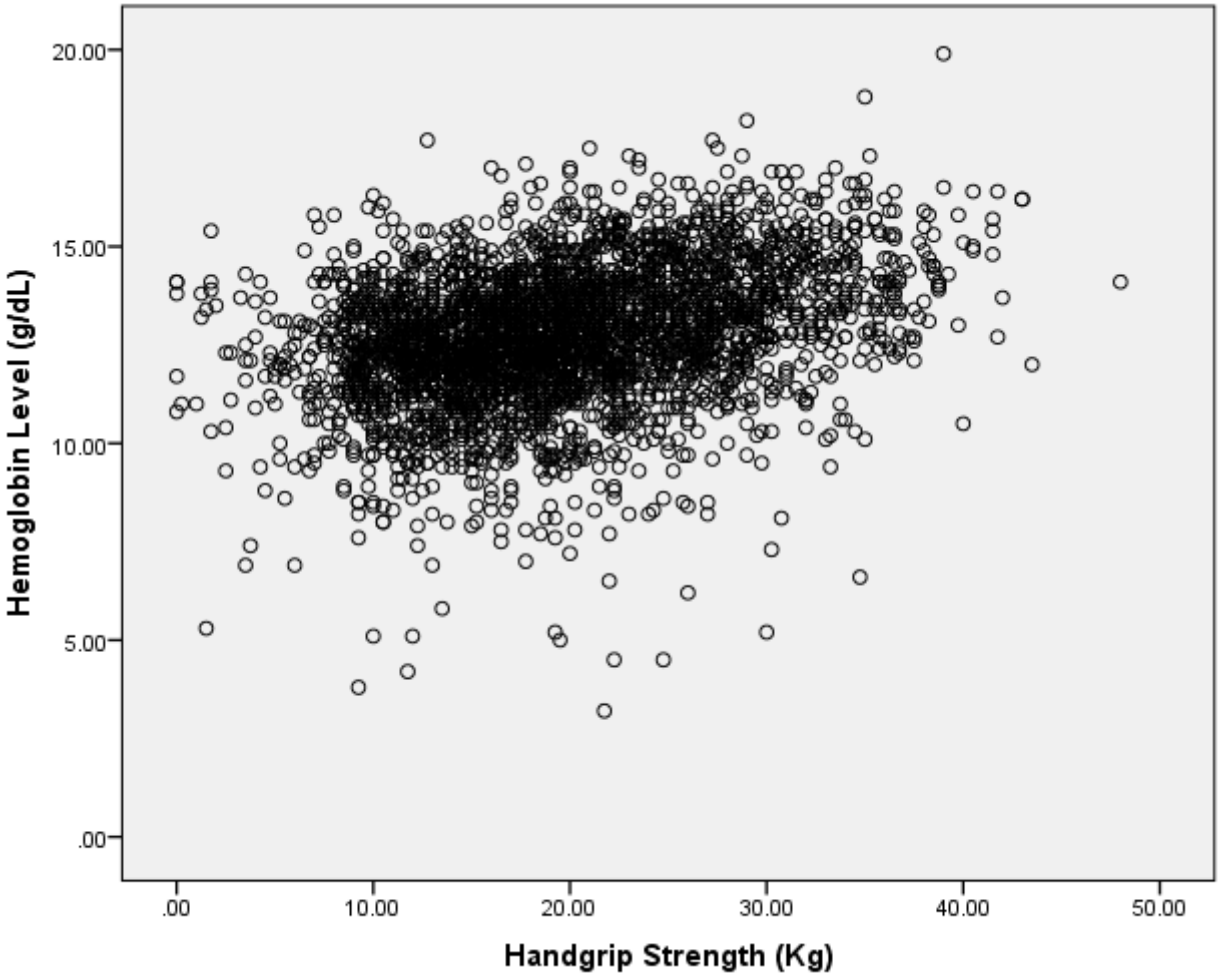

Figure 2

Correlation Between Hemoglobin Level and Handgrip strength in all patient.

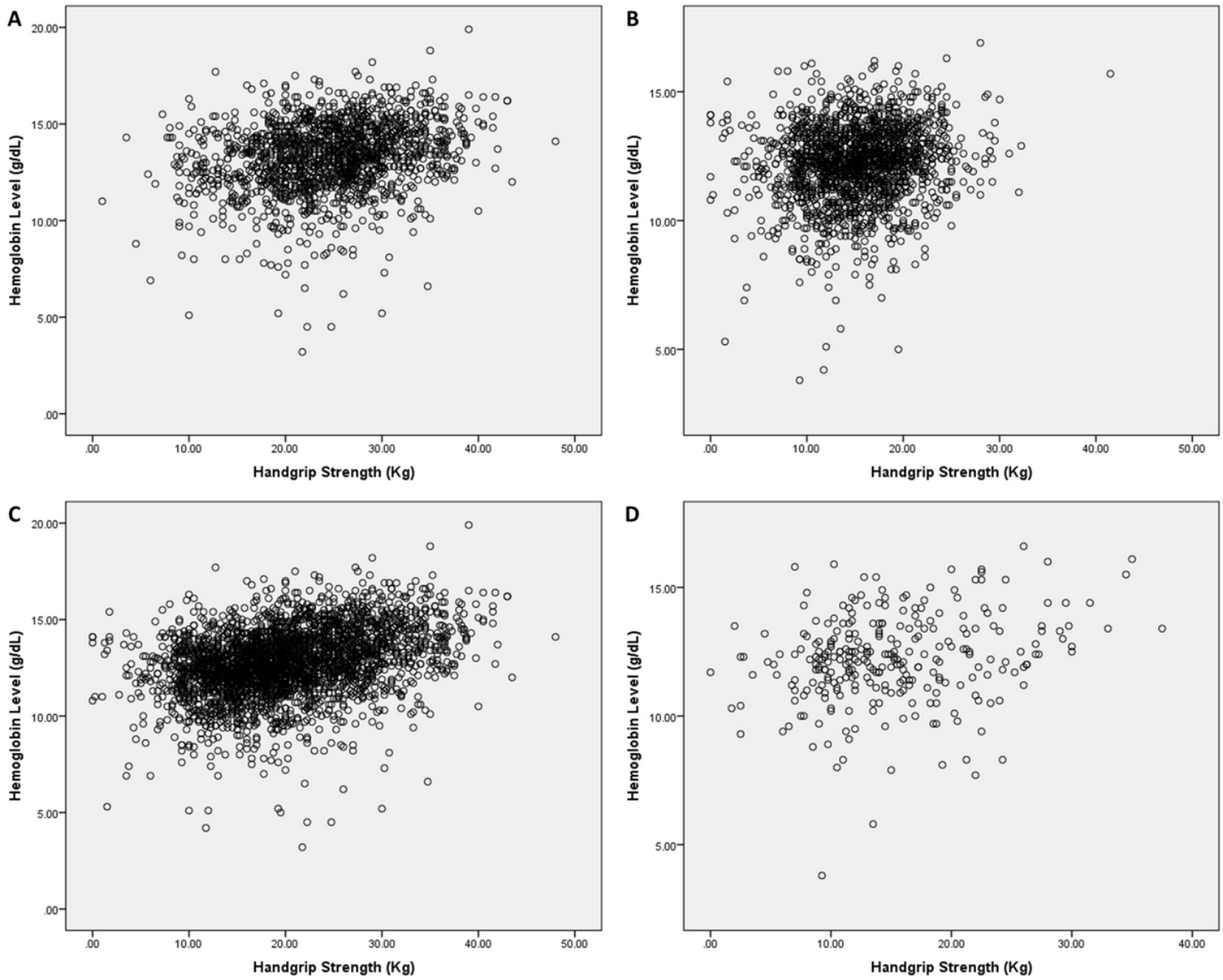

Figure 3

Correlation Between Hemoglobin level and Handgrip Strength stratified by Gender and Age. (A) Males only; (B) Females only; (C) Age 60-80 Only; (D) ≥80 Years Only

Supplementary Files

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