Original article

Association between changes in waist circumferences and disability among older adults: WHO-INDEPTH study on global ageing and adult health (SAGE) in Indonesia

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A B S T R A C T

Background: There is a lack of evidence regarding the impact of changes in waist circumference on disability among older populations in low- and middle-income countries (LMICs). This research examines the association between changes in waist circumference with disability in the older populations of Indonesia, and whether the associations are dependent on wealth or baseline abdominal obesity levels.
Methods: In 2007 the INDEPTH-WHO Study on global AGEing and adult health (SAGE) was conducted among 11,753 individuals aged 50 years and older in Purworejo District, Central Java Province, Indonesia. Of these, a total of 8,089 were followed up in 2010. On both occasions, individuals' waist circumferences were measured and the 12-item version of the WHO Disability Assessment Schedule version 2 (WHODAS-II) was implemented to measure disability.
Results: A significant positive association was observed between waist circumference and disability at the baseline ($\beta = 0.066$; p < 0.001), and between the increase in waist circumference and the level of disability during the three-year follow-up period ($\beta = 0.094$; p < 0.001) after adjusting for baseline variables. This association was also significant among the poor, non-obese men, as well as poor and rich obese women. Among the non-obese women, a decrease in waist circumference was associated with more disabilities.
Conclusions: An increase in waist circumference is associated with increased disability among older people in Purworejo, Indonesia. Health promotion programmes aiming to prevent obesity could have positive effects in preventing and reducing disability among older adults.

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Introduction

Worldwide, the number of older people continues to increase rapidly as fertility and mortality decline. The older population is increasing at a remarkable rate, not only in high-income countries (HICs) but also in low-middle income countries (LMICs) and low-income countries (LICs). This is especially true in Asia. Between 2015 and 2050, the total number of older people aged 80 years and above in 23 Asian countries is projected to increase fourfold [1].

Advances in medical technology, medical discoveries, and health promotion have contributed to the increase in older people's lifespans [2]. This increase in longevity can pose new challenges if this longer-living, older generation experiences a linked increase in functional disabilities [3–5], manifested as difficulty in doing activities of daily life such as household management, personal care,

hobbies, socializing with friends, etc [6,7]. In general, disability is a state determined by both the intrinsic capacity (underlying characteristics of individuals) and contextual (i.e. environments they live in and personal factors) [6]. In HICs, the prevalence of disability is as high as 43% among people aged about 75, compared with 19% among those aged 55–64. The corresponding numbers in LICs are higher at 60% and 29%, respectively [5].

As population ageing occurs alongside the epidemic of chronic non-communicable diseases (NCDs), disability is becoming a more serious concern [2,5]. This is because most health problems in the older population are associated with chronic diseases [2,3,8,9]. Chronic diseases such as diabetes mellitus, hypertension, and cardiovascular disease (CVD), all of which have significant effects on disability [5,8,9], are also strongly related to obesity [5], which is one of the most common risk factors for NCDs.

The prevalence of obesity is increasing globally and has become a serious public health concern. Worldwide, the prevalence of obesity (body mass index (BMI) $\geq 30 \, kg/m^2$) has doubled between 1980 and 2014 [10]. A rise in its prevalence was also observed in
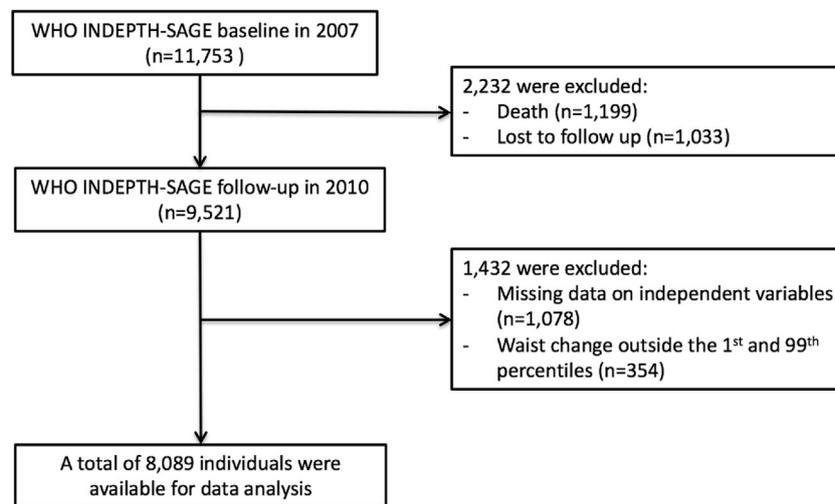
Fig. 1. Flowchart of the inclusion of the study population in the WHO-INDEPTH SAGE Purworejo HDSS panel, 2007–2010.

Indonesia during the last decade [11,12]. Between 1993 and 2007, obesity among people aged 45 years and older has increased from 14% to 31% among women and from 8.5% to 17% among men [12].

Vlassopoulos et al. reported that after the age of 65–70 years, the BMI tended to decrease while the waist circumference continued to increase, thus indicating a redistribution of body fat towards the abdominal region [4]. The findings lead to a discussion on the appropriateness of BMI to measure obesity among older people. Using BMI (a weight-based measurement) alone for assessing obesity among older people can be misleading due to loss of bone mass and density. Several studies recommend the use of waist circumference measurement in assessing obesity among older people [4,8].

Few studies have examined specifically the relationship between obesity and disability among older people: among those that have, some used waist circumference as a key measurement [13–15], while others used both BMI and waist circumference [16,17]. Research on the relationship between changes in waist circumference and onset of disability among older adults is sparse and has yielded inconsistent results [18–20].

In this study, the association between changes in waist circumference and disability among older people in Indonesia is examined. The analysis is extended by stratifying it by gender, wealth status, and baseline abdominal obesity level. A detailed understanding of how changes in waist circumference have led to an increase in disabilities among older people will provide insights that will help with the formulation of a more effective health policy for tackling the problem in the country.

Methods

Study setting

Purworejo District is located in the southern part of Java Island with 712,686 inhabitants in an area of 1035 km². About 90% of the Purworejo district is rural, while the remaining 10% consists of small urban settlements [21].

The WHO-INDEPTH SAGE was conducted within the Purworejo Health and Demographic Surveillance System (HDSS) site, which covers a representative sample of 55,000 individuals living in 14,500 households in the Purworejo district. The sample was chosen through multistage cluster sampling with probability proportional to size, and with the enumeration area as the primary sampling unit and household as the secondary sampling unit [22].

Within this site, individual demographic data (births, deaths, marital status, migration, etc.) were collected annually since 1994, while household socioeconomic data was collected every fifth year.

The WHO-INDEPTH Study on global AGEing and adult health (SAGE) was conducted among people aged 50 years and older in Purworejo District. In 2007, a total of 11,753 older adults aged 50 years and older were recruited to the WHO-INDEPTH SAGE. These individuals were followed up in 2010, among whom 1,199 had died and 1,033 were categorised as lost to follow-up (i.e. 59 refused to participate, 176 were not found at home after three visits, 575 were out-migrated and a further 223 could not be interviewed due to different reasons). Of these 9,521 individuals, 1,078 respondents were excluded due to missing data on key variables (i.e. waist circumference, age, occupation, wealth status) and a further 354 respondents with waist change outside the 1st and 99th percentiles. Thus, 8,089 respondents with complete data (85% of all respondents) were included in the analysis (Fig. 1).

Instruments and variables

We used the individual and household-level WHO-INDEPTH SAGE questionnaires for the study [23]. The individual questionnaire contained information on respondents' socio-demographic characteristics, self-reported chronic conditions, and the WHO Disability Assessment Schedule version 2 (WHODAS-II). The household questionnaire contained information on housing conditions, infrastructure facilities, and the ownership of assets.

The questionnaires were translated into Indonesian, pilot-tested, and translated back into English. The information was collected through face-to-face interviews by trained surveyors. Following an interview, the participant's waist circumference was measured at the point midway between the last palpable rib and the top of the iliac crest using a non-elastic measuring tape [24].

We analysed data on respondent's changes in waist circumference, socio-demographic characteristics (i.e. age, education, occupation, marital status, residence), and self-reported chronic conditions as independent variables and disability based on WHODAS-II as the dependent variable (Table 1).

Analysis

We calculated the mean values and 95% confidence intervals (CIs) for waist circumference and disability scores at the baseline and at follow-up, as well as for changes in waist circumference. Differences in waist circumference and disability scores between

Table 1
Operational definitions of the study variables.

Variables	Categories and definitions
Dependent variable	
Disability	Disability was measured using the 12-question (short version) of WHODAS-II. The WHODAS-II measures difficulties in daily physiological, personal and social functioning within six domains. Each of the questions asks the respondents "*In the last 30 days, how much difficulty/problems did you have with...?*" Responses to these questions were recorded on a 5-point Likert scale of '*none*', '*mild*', '*moderate*', '*severe*', and '*extreme/cannot do*'. The score was then computed in three steps: responses were recoded to a score with a weight ranging from 0 to 4 (step 1), the scores for all 12 questions were summed up to a total score ranging from 0 to 48 (step 2), and the total scores were rescaled to a metric score ranging from 0 to 100 (step 3) where 0 represents no disability and 100 represents full or extreme disability [7].
Independent variables	
Waist circumference	Waist circumference was measured in centimetres. Waist changes were calculated as the absolute change in centimetres between the two surveys. Thus, a negative value indicates a decrease in waist circumference while a positive value indicates an increase in waist circumference from 2007–2010. Abdominal obesity was defined as a waist circumference ≥ 90 cm for men and ≥ 80 cm for women based on the cut-off recommendation for Asian populations [24].
Age group	50-59, 60-69, 70-79, 80+ years.
Education	No formal education: never having any formal education; ≤6 years: not completed elementary school, completed elementary school; >6 years: completed junior high school, high school, academy or university, master's degree.
Occupation	Non-physical labour: government workers, non-government workers or were self-employed; No occupation: retired, housewife, not-having a job; Physical labour: fishermen, farmers, drivers, or rickshaw drivers
Marital status	Single/widowed: not married, divorced, separated, widowed; Partnership: married, living together.
Residence	Coastal, inland, hilly & mountainous
Wealth status	Selected key asset variables in the household level questionnaire were used to create the wealth index as a proxy for household socio-economic status (SES) using principal component analysis (PCA) [25]. The index in this study was divided into a wealth status of 'poor' or 'rich' based on its median.
Self-reported chronic disease	No: did not report having any chronic disease; Yes: reported having at least one (³1) of the chronic conditions including: hypertension, diabetes, stroke, cardiovascular disease (CVD), chronic obstructive pulmonary disease (COPD), and asthma.

groups was estimated using ANOVA. All analyses were stratified by sex, wealth status and abdominal obesity level at the baseline.

The association between baseline waist circumference and disability score in 2007, adjusted for socio-demographic variables, was estimated using multivariable linear regression (Model 1 – baseline model). Further, we analysed the association between changes in waist circumference (2007–2010) and disability score in 2010 in a multivariable model, having been adjusted for waist circumference, disability score, socio-demographic and health-related variables at the baseline using multivariable linear regression (Model 2 – waist change model). Lastly, we repeated the model 2 analysis for each sub-division of sex, wealth status and baseline abdominal obesity. The results were presented in a graph as linear predicted values of disability scores. For presentation purposes, the value of waist circumference change in the graph was centred to zero. All analyses were conducted using Stata version 13 (Stata Corp Texas, 2013).

Ethics

The Ethical Board of the Faculty of Medicine, Gadjah Mada University, Indonesia, granted the ethical approval for this study (IRB number: KE/FK/69/EC). Information about the study was provided to each participant verbally prior to the data collection, followed by the obtaining of written informed consent.

Results

A total of 3798 men and 4291 women were included in the analysis (Table 2). Most men (64%) and women (52%) had ≤6 years of education. 80% of men and 62% of women had a physical labour job, while 11% of men and 29% of women were not working. Most men and women were in partnerships, but the percentage of those in the single/widowed group was higher in women than in men (38% vs 11%). Self-reported chronic disease was higher among women than men (18% vs 15%). Abdominal obesity was seven times more prevalent among women (37% vs 5.4%).

Table 3 shows mean and 95% CIs of waist circumference and disability scores in 2007–2010, as well as changes in waist circumference and disability scores during the three-year period. The mean waist circumference decreased by 1.9 cm and 1.8 cm

Table 2
Basic characteristics of WHO-INDEPTH SAGE participants in Purworejo District, Central Java Province, Indonesia by sex in 2007.

	Men	Women
Sex, N (%)	3798 (47)	4291 (53)
Age, N (%)		
50–59 years	1561 (41)	1715 (40)
60–69 years	1298 (34)	1552 (36)
70–79 years	772 (20)	865 (20)
80+ years	167 (5.0)	159 (4.0)
Education, N (%)		
No formal education	543 (14)	1628 (38)
≤6 years	2430 (64)	2225 (52)
>6 years	825 (22)	438 (10)
Occupation, N (%)		
Non-physical labour	359 (9.0)	371 (9.0)
No occupation	405 (11)	1249 (29)
Physical labour	3034 (80)	2671 (62)
Marital status, N (%)		
Single/widowed	414 (11)	1606 (38)
Partnership	3384 (89)	2685 (62)
Residence, N (%)		
Coastal	1918 (51)	2146 (50)
Inland	881 (23)	1090 (25)
Hilly & mountainous	999 (26)	1055 (25)
Self-reported chronic disease, N (%)		
No	3243 (85)	3533 (82)
Yes	555 (15)	758 (18)
Wealth status, N (%)		
Poor	1844 (49)	2301 (54)
Rich	1954 (51)	1990 (46)
Abdominal obesity, N (%)	207 (5.4)	1582 (37)
Disability score, mean (SD)	10.7 (13.2)	13.8 (15.1)

SD = standard deviation.

respectively among men and women. Even though the mean waist circumference was higher among the rich in both sexes, it decreased more among the poor compared to the rich (2.4 cm vs 1.5 cm; p < 0.001 among men, and 2.2 cm vs 1.4 cm; p < 0.001 among women, respectively). Obese men and women showed

Table 4

Two models of multivariable linear regression analysis of waist circumference and disability (β coefficient and 95% CI) of WHO-INDEPTH SAGE in Purworejo District, Central Java Province, Indonesia during 2007–2010.

Variables	Baseline model[b] β (95% CI)	Waist change model[c] β (95% CI)
Waist circumference in 2007	0.066 (0.032, 0.10)[*]	
Waist circumference change (cm)		0.094 (0.051, 0.13)[*]
Waist circumference in 2007[a]		0.029 (−0.011, 0.069)
Disability score in 2007[a]		0.17 (0.15, 0.20)[*]
Sex		
Men	Ref.	Ref.
Women	0.86 (0.22, 1.5)[*]	1.5 (0.82, 2.2)[*]
Age (years)		
50–59	Ref.	Ref.
60–69	3.4 (2.7, 4.1)[*]	4.0 (3.2, 4.7)[*]
70–79	8.6 (7.8, 9.5)[*]	10 (9.5, 11)[*]
80+	14 (13, 16)[*]	17 (15, 19)[*]
Education		
>6 years	Ref.	Ref.
≤6 years	2.2 (1.3, 3.1)[*]	1.6 (0.62, 2.5)[*]
No formal education	4.9 (3.8, 5.9)[*]	3.7 (2.5, 4.8)[*]
Occupation		
Physical labour	Ref.	Ref.
Non-physical labour	−0.78 (−1.9, 0.28)	1.5 (0.32, 2.6)[*]
No occupation	3.9 (3.2, 4.8)[*]	2.7 (1.8, 3.6)[*]
Marital status		
Partnership	Ref.	Ref.
Single/widowed	1.7 (0.98, 2.4)[*]	1.1 (0.38, 1.9)[*]
Residence		
Coastal	Ref.	Ref.
Inland	0.85 (0.15, 1.5)[*]	1.6 (0.89, 2.4)[*]
Hilly & mountainous	−0.24 (−0.98, 0.49)	3.3 (2.5, 4.1)[*]
Self-reported chronic disease		
No	Ref.	Ref.
Yes	4.1 (3.3, 4.9)[*]	2.5 (1.7, 3.3)[*]
Wealth status		
Rich	Ref.	Ref.
Poor	1.1 (0.44, 1.7)[*]	1.6 (0.91, 2.3)[*]

[a] Centred to the mean.

[b] Baseline model (cross sectional): WHODAS-II score in 2007 as the dependent variable regressed on baseline waist circumference and socio-demographic variables in 2007.

[c] Waist change model: WHODAS-II score in 2010 as the dependent variable regressed on waist circumference change during 2007–2010, baseline waist circumference, disability score, socio-demographic and health-related variables.

[*] Significant coefficient (p < 0.05).

larger decreases in mean waist circumference compared to the non-obese groups.

Table 3 shows that on average at group level, waist circumference decreased, and disability increased over time in both sexes. Disability increased with an overall change of 4.3 and 4.9 units of score in men and women, respectively. Poor men and women had significantly higher disability scores compared to their rich counterparts, both at the baseline and at follow-up. They also had a larger increase in their disability score (5.3 cm vs 3.4 cm in men; p < 0.001 and 5.7 cm vs 3.9 cm in women; p < 0.001, respectively). No significant difference in disability score changes was observed between obese and non-obese men. Non-obese women had a significantly larger increase in their disability scores compared to obese women.

Table 4 presents the regression coefficient of the multivariable linear regression analysis of disability. The baseline model showed that waist circumference was associated positively with disability, as an increase of 1 cm in waist circumference led to a higher disability score by 0.066 units (95% CI = 0.032, 0.10). The disability was significantly higher among women compared to men and increased substantially with age. The disability was higher among those who had a lower level of education, those without any occupation, those who were single/widowed, those living in the inland area, those having chronic diseases and those who were poor.

The waist change model showed that for every centimetre increase in waist circumference change, the disability score increased by 0.094 units (95% CI = 0.051, 0.13), after controlling for waist circumference and disability score in 2007 and all other socioeconomic, demographic and health-related variables. Being a woman, being older, having a lower education level, being engaged in non-physical labour and having no occupation, being single/widowed, living inland, hilly and mountainous areas, having chronic diseases and being poor were significantly associated with increases in the disability. When the model was built separately for men and women, we observed positive association between waist circumference change and disability score, with a coefficient of 0.096 (95% CI = 0.04, 0.15) among women and 0.081 (95% CI = 0.013, 0.15) among men (Appendix 1). Though significant, the slope of the regression line among women was less steep than the one for men (Appendix 2).

Fig. 2 shows the estimated disability score associated with changes in waist circumference, controlled for waist circumference, disability score and socio-demographic variables at the baseline. An increase in waist circumference was significantly associated with more disability, and conversely, a decrease in waist circumference was significantly associated with less disability among the poor, non-obese men (β = 0.12; 95% CI = 0.00038, 0.23) as well as poor and rich obese women (β = 0.17; 95% CI = 0.028, 0.30 and β = 0.16; 95% CI = 0.052, 0.27).

Regardless of wealth, the regression slope was steeper among the obese, indicating that changes in waist circumference (either an increase or decrease) had a larger effect on disability in this group. Furthermore, women had more disabilities than men. Among the non-obese women, a decrease in waist circumference was associated with more disabilities, and conversely, an increase in waist circumference resulted in fewer disabilities.

Discussion

The study found a strong association between waist circumference and disability in men and women aged 50 years and older in Purworejo District, Indonesia. This finding is consistent with a recent cross-sectional study among older Brazilian adults aged 60 years and above that showed that abdominal obesity was a substantial risk factor for disability [14]. A prospective cohort study among older Spanish adults also found that larger waist circumference predicted disability [26]. Batsis et al. demonstrated a similar association between larger waist circumferences and higher risks of disability in their cohort study among adults aged 65 years and above in the US [13].

A robust relationship between changes in waist circumference and disability was also detected as a result of this study; the results are consistent across baseline wealth status and abdominal obesity levels. It was observed that increases in waist circumference had a more substantial effect on the increase of disability in men and women who were already obese (as defined by their waist circumference). However, for non-obese women, a decrease in waist circumference was associated with more disabilities, and conversely, an increase in waist circumference resulted in fewer disabilities. This finding indicates the importance for non-obese women, especially the poor, to maintain their waist circumference.

A few studies have identified the health-related consequences of increasing fat deposition in the abdomen [18,20], especially among older people [8]. Increasing waist circumference was reported to be associated with more prevalent cardio-metabolic risk factors in French men and women aged 30–64 years old [18]. Tyrovolas

Table 3
Mean waist circumference (95% CI) and mean disability (WHODAS-II) score of WHO-INDEPTH SAGE in Purworejo District, Central Java Province, Indonesia in year 2007 and 2010 and the corresponding changes during 2007–2010.

Socio-demographic characteristics in 2007	Waist circumference in cm (95% confidence interval)			Disability score (95% confidence interval)		
	2007	2010	Δ Waist	2007	2010	Δ Disability
Men	76.5 (76.2, 76.7)	74.5 (74.3, 74.8)	−1.9 (−2.2, −1.7)	10.7 (10.3, 11.1)	15.1 (14.6, 15.5)	4.3 (3.8, 4.9)
Wealth status						
Poor	75.1 (74.8, 75.4)*	72.7 (72.4, 73.1)*	−2.4 (−2.7, −2.0)*	12.0 (11.3, 12.6)*	17.3 (16.5, 18.0)*	5.3 (4.4, 6.1)*
Rich	77.8 (77.4, 78.2)	76.2 (75.9, 76.6)	−1.5 (−1.9, −1.2)	9.52 (8.98, 10.0)	13.0 (12.3, 13.6)	3.4 (2.7, 4.1)
Abdominal obesity						
Non-obese	75.5 (75.2, 75.7)*	73.7 (73.5, 74.0)*	−1.7 (−1.9, −1.4)*	10.7 (10.3, 11.2)	15.2 (14.7, 15.7)	4.4 (3.8, 5.0)
Obese	94.5 (93.8, 95.2)	88.5 (87.3, 89.8)	−5.9 (−7.0, −4.9)	10.1 (8.31, 11.9)	13.1 (11.0, 15.2)	3.0 (0.7, 5.3)
Women	76.8 (76.5, 77.1)	75.0 (74.7, 75.3)	−1.8 (−2.1, −1.6)	13.8 (13.4, 14.3)	18.7 (18.2, 19.2)	4.9 (4.3, 5.4)
Wealth status						
Poor	75.2 (74.9, 75.6)*	73.1 (72.7, 73.4)*	−2.2 (−2.5, −1.8)*	14.9 (14.3, 15.5)*	20.6 (20.0, 21.3)*	5.7 (4.9, 6.5)*
Rich	78.6 (78.2, 79.1)	77.2 (76.7, 77.6)	−1.4 (−1.8, −1.1)	12.6 (12.0, 13.2)	16.4 (15.8, 17.1)	3.9 (3.1, 4.6)
Abdominal obesity						
Non-obese	71.0 (70.8, 71.2)*	71.2 (70.9, 71.5)*	0.2 (−0.1, 0.5)*	14.0 (13.4, 14.5)	19.3 (18.7, 19.9)*	5.3 (4.6, 6.0)*
Obese	86.7 (86.3, 87.0)	81.4 (80.9, 81.9)	−5.2 (−5.6, −4.8)	13.6 (12.8, 14.3)	17.6 (16.9, 18.4)	4.0 (3.1, 4.9)

Δ Absolute change between the two surveys (2010–2007).

* Significant (p < 0.05) in ANOVA test of difference in waist circumference and disability score between groups (poor vs rich, non-obese vs obese).
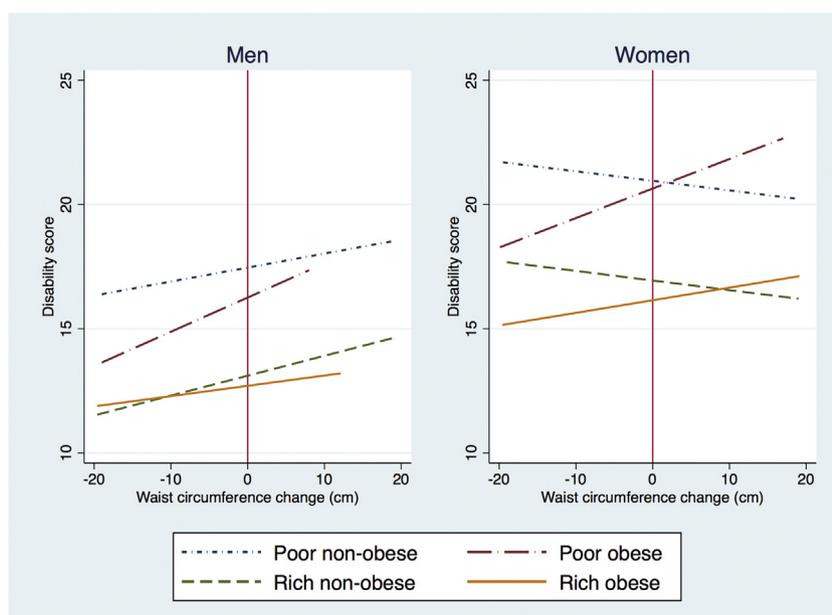

Fig. 2. The association between changes in waist circumference 2007–2010 and disability score stratified by wealth and abdominal obesity status in men and women.

et al. highlight the importance of controlling waist circumference in the older population, given that waist circumference was seen to have a significant association with diabetes mellitus and disability in seven out of nine countries studied (i.e. China, Ghana, India, Mexico, Russia, South Africa, Finland, Poland, Spain) [8]. Luo et al. found that a change in waist circumference was a better predictor than a change in BMI for the incidence of type-2 diabetes mellitus among adults aged 38–64 years in Jiangsu Province, China [20]. This suggests that older people need to maintain their waist circumference as it will be beneficial in reducing disability risk.

In this study, older adults with a low SES were found to report disability more commonly. Consistent with this finding, others have reported a lower prevalence of physical impairment, functional limitations, and disability among the richest in China and India [27].

We also found that the poor tend to have a larger decrease in waist circumference than their wealthier counterparts. This might be explained by their consumption levels, as shown in a recent systematic review of consumption levels and sources of added sugars in Indonesia [28]. In their review, Atmarita et al. found that the poor consumed less sugar and carbohydrates compared to the rich. The poor might have limited food choice and consumption, which may cause undernutrition and worse health status [28].

This study demonstrates the need of different strategies in tackling abdominal obesity and disability are needed at a different socio-economic level. Among the wealthy, where obese older adults were more prevalent, health promotion strategies should focus on reducing waist circumference to decrease the level and severity of disabilities. For the poor, maintaining adequate nutrition intake might be more important in the prevention of disabilities.

Policy implications

Demographic transition in many LMICs occurs at a fast rate, and it contributes to the fast growth of an ageing population [1]. In these settings, including Indonesia, quality care and specialised health services to address older people's health needs are limited [1]. At

the same time, nutrition transition is occurring in the country with the double burden of malnutrition (co-existence of undernutrition and obesity in the population) [29]. To date, the Indonesian government has prioritised a national health programme to address undernutrition (underweight or stunting), especially among children [29], while obesity has received less attention [11,29].

The steady growth of Indonesia's national economy contributes to the nutrition transition in the country, with changing patterns of consumption from traditional diets to modern diets [29]. Concurrently, sedentary lifestyles and obesity have become more common, and all these factors contribute to an increase in the prevalence of chronic disease in Indonesia [11,29].

As medical discoveries and advanced technology in chronic diseases have increased people's life expectancy, chronic diseases among older people are closely related to disability [9]. Several studies have demonstrated the association between obesity in older people with a broad range of diseases, complications, and disabilities [8,14,16,17,19,26,30]. In Indonesia, the national basic health survey showed that in 2013 the prevalence of disability among older persons aged 55–64, 65–74 and ≥75 years was 19%, 35% and 56%, respectively [32]. Disability with the presence of chronic comorbidity will increase the need for care and affects older people's health and quality of life [3,31]. Furthermore, disability will have an immense impact on their families and the entire health-care system [2]. These phenomena can lead to a significant burden on the country if the increase in life expectancy does not go hand in hand with a delay in the onset of disability, leading to the expansion of morbidity rather than the compression of it [33].

Efforts to understand and address the problem of obesity among older population are challenging due to disagreements about the best measurement tool and cut-offs for obesity among older people. In Indonesia, several studies to measure overweight and obesity rates within the country has been conducted [11]. However, results of these studies are difficult to use for comparison as they have used different measurement methods and cut-offs. The Indonesian government may need to evaluate and develop specific cut-offs to better monitor overweight and obesity rates.

Furthermore, concerns regarding the obesity paradox (where obesity may be protective and associated with greater survival), as well as the benefits and risks of weight loss among obese older adults, are still unclear [19,20,30]. This study offers compelling evidence for developing intervention programmes to prevent abdominal obesity among older adults in our settings. Intervention through the promotion of physical activity and adequate nutrition intake to maintain healthy waist circumference should be recommended to achieve optimum health and prevent disability among the non-obese older population. These interventions could be achieved by utilising the community health post's programme for NCD prevention that has good coverage in Indonesia. The community health post programme called *POSBINDU PTM*, aimed to detect the NCD risk factors through routine measurements of e.g. height, weight, waist circumference, as well as to offer health promotion in targeted populations within the community, such as groups of elderly people [34].

Strengths and limitations of the study

This study contributes to the filling in of the gaps of knowledge on the longitudinal impacts of changes in waist circumference on disability—a research area which has been non-existent in Indonesia. The fact that this study was conducted on a large representative sample of older adults in a well-established demographic site at district level and was part of the WHO-INDEPTH SAGE survey with more than a 90% follow-up rate was one of the strengths of this study.

The use of waist circumference is also a strong point of this study. The usefulness of BMI as a measure of obesity among older people has been debated [4]. Several studies have recommended waist circumference as a more appropriate measure for adiposity and obesity among older people [4,14].

This study has several limitations. First, the WHO-INDEPTH SAGE survey covered a representative sample of the older population in Purworejo District, Central Java Province, Indonesia, hence the results reported in this study are not nationally representative. Second, this study is not comparable to other studies that use BMI to assess obesity. Self-reported height and weight data were not utilised in this study as they contained many missing values (up to 45% combined). Estimates based on self-reported height and weight, however, tend to be biased as people tend to under-report their weight and over-report their height [35]. Future studies should consider including BMI measurement to be able to explore and compare the strength of association between disability and waist circumference or with BMI.

Conclusion

Larger waist circumference is associated with more disability among older people in Indonesia. Except in the case of non-obese women, an increase in waist circumference is also associated with increasing disability. Health promotion programmes should aim at reducing waist circumference among obese older adults so as to decrease the level and severity of disabilities. Specific strategies such as nutrition counselling, to ensure adequate nutrient intake, should also be given to prevent decreasing waist circumference among non-obese women, as it too is associated with more disability.

Conflict of interest

None declared.

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Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:https://doi.org/10.1016/j.orcp.2019.07.004.

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